Chapter 3
Affected Environment

3.1 PROJECT BACKGROUND

The following descriptions of the affected environment provide a basis for understanding the direct, indirect, and cumulative effects of the HFBR operational scenarios and alternatives. The characteristics of each potentially affected environmental resource are described for each alternative. The scope of the discussions varies by resource to ensure that all relevant issues are included.

For land use and visual resources, geology and seismicity, ecology, and cultural resources, discussions of the HFBR site and its surroundings are included along with descriptions of the representative area within BNL that could be affected by the various alternatives. This information provides a basis for understanding both direct effects and the overall resource base.

Ambient conditions are described for air and water resources. Discussions focus on air conditions at BNL boundaries and the surface water bodies and groundwater aquifers that could be affected. This information serves as a basis for analyzing key air and water quality parameters to obtain results that can then be compared to regulatory standards.

Socioeconomic conditions are described for the counties and communities that could be affected by regional population changes associated with the various HFBR operational conditions and associated alternatives. The affected environment discusses the region and related socioeconomic indicators. Each alternative accounts for changes related to direct project employment as well as secondary jobs that may be created or lost.

In addition to those natural and human environmental resources discussed above, the affected environment sections include a number of issues related to ongoing activities at BNL. These issues involve facility operations and site infrastructure, intersite transport of nuclear materials, waste management, and radiological and hazardous chemical impacts during normal operation and from accidents. Where reasonably foreseeable changes to any of these factors can be predicted, they are discussed.

3.2 LAND USE/VISUAL RESOURCES

3.2.1 BACKGROUND TO LAND USE/VISUAL RESOURCES

3.2.1.1 Definition of Resources

Land Use: Land resources comprise all of the terrestrial areas available for economic production, residential or recreational use, government activities, or for natural resource protection. Concerns could result from changes in land use, conflicts with the objectives of applicable land use plans, policies, and controls, and the degree of any land disturbance associated with the alternatives.

Visual Resources: Visual resources are natural and human-created features that give a particular setting its character and aesthetic quality. Visual character and aesthetic quality are determined by architectural elements (building designs), landscape features (rolling hills, open fields), and exposure to public view from off of the site. All three elements are present in every visual resource, however they exert varying degrees of influence. The blend of aesthetically pleasing architectural and landscape elements results in pleasant visual resources.

3.2.1.2 Approach to Defining Environmental Setting

Land Use: The environmental setting for land resources is defined first by delineating the region of influence (ROI) and then gathering information on land-use patterns and densities pertaining to that area. The land-use ROI for the evaluated alternatives is 3.2 km (2 mi) from the HFBR facility. This distance was selected to include all of the BNL property as well as a variety of adjacent Town of Brookhaven land uses. Land use data were obtained from the Town of Brookhaven (TOB 1996).

Visual Resources: Visual resources were identified based on a review of the findings of existing land use reports, other background documents describing visual resources in the site vicinity, and observations of the site.

3.2.2 AFFECTED ENVIRONMENT

BNL is surrounded by the Town of Brookhaven, Suffolk County, New York. The BNL facility encompasses approximately 2,150 ha (5,300 acres). The HFBR lies in the central area of the BNL facility (Figure 3.2-1), being 2,400 m (8,050 ft) from the north boundary, 2,100 m (7,000 ft) from the south boundary, 1,800 m (5,800 ft) from the east boundary, and 3,100 m (10,200 ft) from the west boundary.

3.2.2.1 Land Use

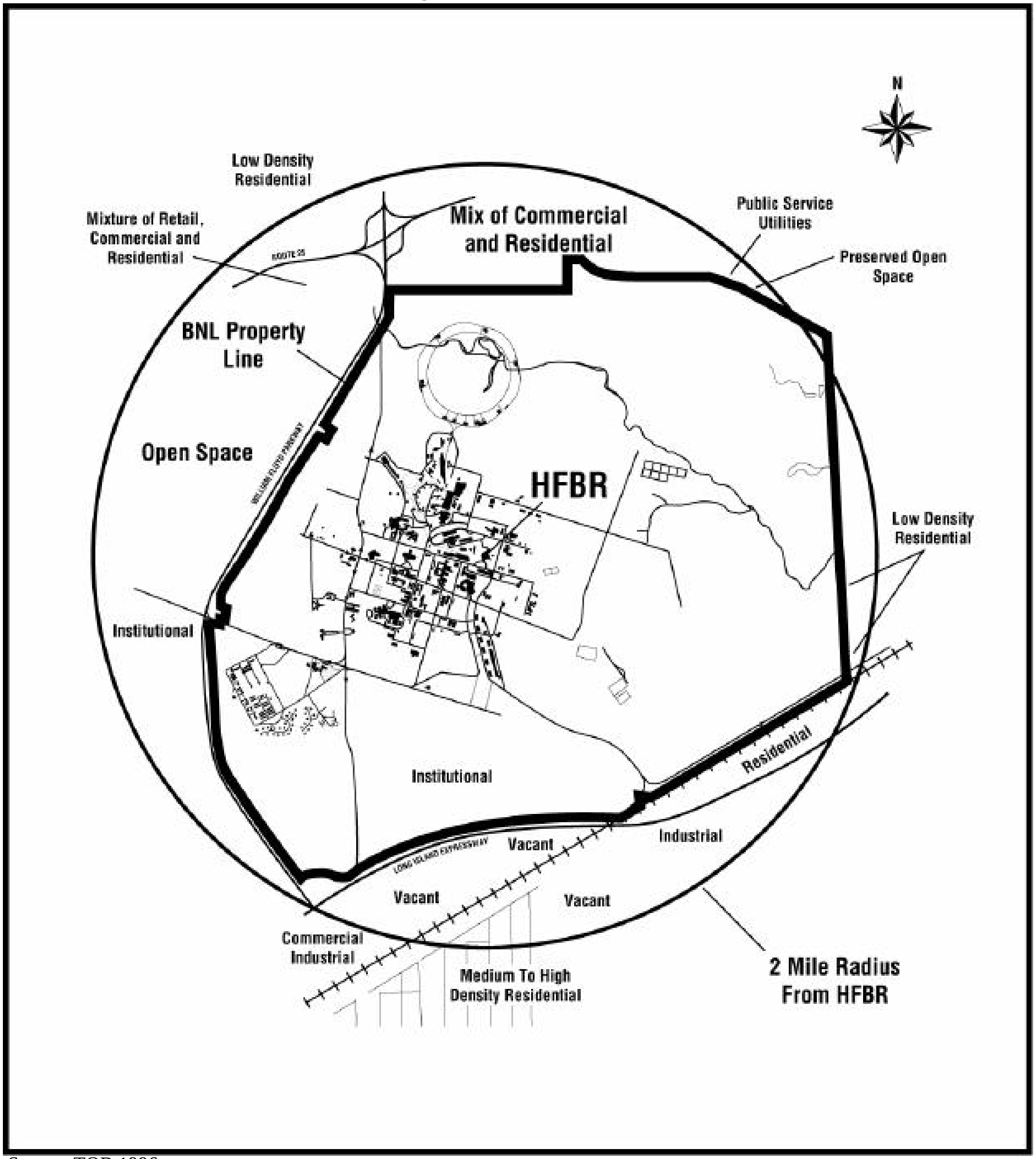
Figure 3.2-1 presents a land use map of the site and surrounding area within 3.2 km (2 mi) of the HFBR (the ROI). As shown in this figure, land use outside of the BNL facility includes:

- East: preserved open space (Peconic River County Park) and low density residential
- North: mixture of residential, commercial/industrial, and public service utilities
- West: institutional, open space, and low density residential
- South: commercial/industrial, vacant land, and medium to high density residential

The 1996 Land Use Plan developed by the Town of Brookhaven (TOB 1996) defines the land use categories identified on Figure 3.2-1 as follows:

- Low Density Residential – Residential development with an overall net density of one dwelling unit or less per acre.
- Medium-High Density Residential – Residential development with an overall net density of two dwelling units per acre.
- Vacant Land – Land which is undeveloped and is not utilized. This may include woodland, old field and bare earth sites.
- Retail-Commercial – Commercial uses devoted to the sale of retail merchandise such as department stores and specialty shops.

Figure 3.2-1. Land Use.



Source: TOB 1996.

- Commercial – Commercial uses which are not devoted to retail such as auto services, professional offices (accounting, law).
- Institutional – Public and private non-profit uses including municipal offices, fire departments, ambulance, churches, schools, colleges, BNL, libraries, hospitals and post offices.
- Preserved Open Space – Public and private land which has been dedicated for more active public recreational uses and which will not be developed.

Development of BNL has been significantly influenced by the buildings and utilities inherited from the former Camp Upton. The layout of the roads, buildings, and utilities are a legacy of the former Army base. In its *Future Land Use Plan*, BNL divided land use onsite into four categories (BNL 1995a):

- Open Space
- Industrial/Commercial
- Agricultural
- Residential

Each of these categories is described below.

Open Space: Open space comprises approximately 75 percent of BNL. The open area is generally in its natural state with the exception of fire breaks, utility rights-of-way, recreation fields, and environmental monitoring wells and stations. This area includes floodplains and wetlands. The floodplain areas border the headwaters of the Peconic River in the northern area of the site, while the wetlands are predominantly in the eastern section of the site. BNL facilities, with the exception of portions of the RHIC ring, do not encroach on the one-hundred-year floodplains or wetlands. The open space surrounding the developed central area of the site forms a buffer zone for the industrial/commercial land use areas. There are no plans to further develop land in the western portion of the site. The area between Upton Road, William Floyd Parkway, and Princeton Avenue is planned to be kept as a buffer zone with forest and grassy areas. Similarly, current plans for woodlands and wetlands to the east are to leave them in their natural state (BNL 1995a).

Industrial/Commercial: The four designated user research facilities (the AGS, NSLS, Scanning Transmission Electron Microscope [STEM], and the HFBR) serve the scientific community from the United States and abroad and are the centerpieces of the industrial/commercial land use area. RHIC, which completed construction in June 1999 and has begun operations, will be an additional unique user research facility within this land use category. Approximately 3 ha (7 acres) of BNL is leased to the U.S. Department of Commerce for weather facilities. These facilities are part of the National Weather Forecasting Network operated by the National Oceanic and Atmospheric Administration. Other facilities housing nine scientific departments, four scientific support divisions, and thirteen support divisions are also within this industrial/commercial area. With the exception of the Sewage Treatment Plant (STP) and the new Waste Management Facility (WMF), the industrial/commercial facilities form the developed central area of the site (BNL 1995a).

The majority of BNL's buildings are located in the industrial/commercial area. At present, 62 wooden buildings and over 225 trailers provide temporary space. Permanent buildings have a total floor area of about 340,000 m^2 (3,660,000 ft^2). The existing facilities of the site's core area can broadly be characterized into four functional zones: support services, research machines, physical sciences laboratories, and life sciences laboratories. This functional layout was influenced by the layout of the basic infrastructure, utilities, and other services (BNL 1995a).

Agricultural: Approximately 28 ha (70 acres) of BNL are used for growing crops for biological research. Currently, these fields are used for growing corn, however other crops have been grown in the past and are likely to be grown in the future. The fields are located in the eastern area of the site and are surrounded by natural vegetation and open space (BNL 1995a).

Residential: BNL faces increasing demands to accommodate both U.S. and foreign users, visitors, and other staff with temporary appointments. The housing inventory, largely inherited from the Army, is composed of summer cottages, mobile homes, apartments, efficiencies (apartment units with small kitchens), guest rooms, dormitory rooms, and houses. Approximately 70 ha (175 acres) are designated for this purpose. The 19 buildings used for apartments, four dormitory structures, and the guest rooms building are Army buildings converted for residential use; on average, approximately 550 people live onsite. The bulk of this residential area lies in the southwest segment of the site. There is a day care center near the residential area, at which about 100 children are enrolled. A natural growth of scrub oak and pine surrounds the residential complex which consists of the apartment area, cottages, efficiencies, and BNL's child care facility (BNL 1995a).

3.2.2.2 Visual Resources

The Town of Brookhaven contains many significant environmental features that represent visual resources and are an integral part of the town's quality-of-life resources. Included among the visual resources are roads, bridges, government buildings, communication towers, houses, commercial and industrial areas, parks, farms, schools, and hospitals. In addition, visual resources include environmental and geologic features (such as kettleholes, moraines, glacial erratics), wetlands, rivers, freshwater ponds, and the Pine Barrens. The Town of Brookhaven is relatively flat, however there are areas of rolling terrain. Such terrain consists of glacial moraines which are found along the central and northern portions of the town. The two major moraines are the Harbor Hill moraine, located along the north shore, and the Ronkonkoma moraine which runs through the center of the town (TOB 1996). Wetlands provide a habitat for breeding and nursery grounds for wildlife and are found throughout the Town of Brookhaven, primarily along river beds such as the Carmans, Forge, and Peconic River systems (TOB 1996).

BNL lies in a section of the Oak-Chestnut Forest Region known as the Atlantic Coastal Plain Physiographic Province. The site is on the west rim of the shallow Peconic River watershed, which is bordered by two lines of low hills which extend east and west nearly the full length of Long Island. The terrain within BNL is gently rolling, with elevations varying between 13 m and 37 m (44 ft and 120 ft) above sea level (BNL 1995a).

The BNL property line is bordered by indigenous evergreen trees having a dark green dense texture which visually isolates the facility from the surrounding communities. Within the facility, landforms include roads, flat to rolling topography, closed landfills, grass fields, and landscape features. Structural features include a research campus-like setting with laboratories, research facilities, hospital, housing, gas station, recreational facilities, offices, and parking lots. Spatially, facility structures are centrally located within BNL with fields and dense vegetation encircling the core area. Portions of the Peconic River, located predominantly east of BNL, are protected under the New York State *Wild, Scenic, and Recreational River Systems Act*. The dense evergreen tree buffer along the eastern property line effectively isolates BNL from the scenic values of the river offsite.

Of the approximately 2,150 ha (5,300 acres) that comprise BNL, approximately 670 ha (1,675 acres) are developed and the balance is largely wooded. The site contains fresh water ponds, wetlands, the headwaters of the Peconic River, and forested areas comprising the Pine Barrens. The HFBR is located within the developed portion of the site and is approximately 550 m (1,800 ft) from the nearest BNL designated open space (BNL 1995a).

The HFBR (Building 750) is a steel hemispherical structure formed of welded steel plates supported upon an I-beam framework, resting on a cylindrical base and is visible from onsite. Supporting facilities of the HFBR include the stack (Building 705), cooling towers, the fan house (Building 704) and several other minor structures (BNL 1996a). None of these facilities is visible at ground level from the property line. This visual buffer is a result of the HFBR's distance from the property line as well as the presence of a thick tree line around the property. However, the stack is visible at some distances from several areas offsite.

3.3 INFRASTRUCTURE

3.3.1 BACKGROUND TO INFRASTRUCTURE

3.3.1.1 Definition of Resources

Infrastructure includes those utilities and other resources required to support construction, operation, or decommissioning activities associated with the HFBR. The resources described and analyzed in this EIS include electrical power and electrical load capacity requirements, water and steam supply requirements, fuel (natural gas and oil) requirements, sewage requirements, and land requirements such as roads and railroads.

3.3.1.2 Approach to Defining Environmental Setting

Site-specific data information documents, site development and planning documents, other site NEPA documents, facility description and operations manuals, and site environmental reports were used to determine infrastructure conditions and requirements for the various alternatives.

3.3.2 AFFECTED ENVIRONMENT

When founded in 1947, BNL was considered to be located in a rather remote area, with abundant land, vegetation, and water. BNL activities have steadily grown, and the nearby offsite population, with attendant infrastructure such as electric power, water supply, and sewer systems, has increased over the years. BNL is located close to the geographic center of Suffolk County, and approximately 100 km (60 mi) east of New York City. It consists of approximately 2,150 ha (5,300 acres), most of which is wooded. BNL is just north of Interstate Highway I-495 (Long Island Expressway [LIE]), with its main entrance off County Route 46 (William Floyd Parkway). BNL is served by the Long Island Rail Road (LIRR), which lies to the south, via a 2.7 km (1.7 mi) spur. The closest commercial airport, the Long Island MacArthur Airport, is about 30 km (19 mi) to the southwest, with La Guardia Airport and John F. Kennedy International Airport about 80 km (50 mi) to the west (BNL 1995a).

Development of BNL has been influenced by the buildings and utilities inherited from the former Camp Upton. The general location and arrangement of the roads, buildings, and utilities are a legacy of this former U.S. Army camp. The physical plant has been upgraded gradually over the last 48 years, but many of the original Army elements are still used and will continue to be accommodated in future planning. Most of the principal facilities on the site are located near the center of the site. The HFBR, which is centrally located within BNL (about 2 km [1.2 mi] from the eastern boundary and 3 km [2 mi] from the southern boundary), occupies approximately 4 ha (10 acres) and was commissioned in 1965 as a scientific research facility (BNL 1995a, BNL 1996a).

To support the current missions at BNL and the HFBR, an extensive infrastructure exists as shown in Table 3.3-1. Water is pumped from onsite supply wells, and after any required treatment, is used for either potable or process needs. Two water towers with a combined capacity of about 5 million l (1.3 million gal) are used to maintain system pressure. There are approximately 72 km (45 mi) of distribution piping. Water is used at the HFBR for building air conditioning, fire sprinklers and standpipes, secondary water system makeup, normal staff use, and miscellaneous plant equipment makeup and cooling.

The sewage system consists of approximately 50 km (30 mi) of piping, most dating back to World War II. There is an ongoing major project to repair or replace this piping. A new sewage treatment plant with a planned 6 million l per day (MLD) (1.5 million gal per day [MGD]) capacity has been constructed and opened in December, 1997. This plant supplements the existing sewage treatment plant that has an 11 MLD (3 MGD) capacity (BNL 1995a, BNL 1997a).

Table 3.3-1. Baseline Infrastructure Characteristics for BNL and the HFBR

Infrastructure Characteristics	BNL Site	HFBR
Land		
Total Site Area (ha)	2,150	--
Developed Site Area (ha)	670	4
Roads (km)	70	--
Railroads (km)	2.7	--
Electrical		
Energy Consumption (MWh/yr)	220,000	4,000
Peak Load (MWe)	54	0.5
Fuel		
Oil (liters/yr)	1.9×10^6	--
Natural Gas (m^3/yr)	1.7×10^7	--
Steam		
Usage (kg/yr)	2.7×10^8	4.5×10^6
Peak Demand (kg/s)	22	0.76
Water		
Well Production Capacity (MLD)	39	--
Treatment Plant Capacity (MLD)	23	--
Usage (MLD)	14.1	0.2
Sewage		
Treatment Facility Capacity (MLD)	11	--
Usage[a] (MLD)	5	--

[a] The listed usage is for the summer when it is the highest.
Source: BNL 1995a; BNL 1996a; BNL 1996b; BNL 1998a; BNL 1998b; Ports 1998a.

Electricity is purchased from the New York Power Authority (NYPA), the former Long Island Lighting Company (LILCO), and the Long Island Power Authority (LIPA). The current peak demand of 54 MWe is expected to increase to 75 MWe by the year 2000 due to RHIC operation. BNL has two main substations for stepping down the power from 69 kilovolts (KV) to 13.8 KV (BNL 1995a).

Steam for site heating and other requirements is produced in a central steam facility. This facility contains four boilers with a combined capacity of approximately 180,000 kg per hour (400,000 lb per hour) of steam. No. 6 fuel oil (approximately 19 million l per year [5 million gal per year]) purchased from a commercial fuel supplier was the primary fuel source to fire the boilers in the past; however, a natural gas connection was recently established for this purpose. Natural gas is purchased from Brooklyn Union Gas. A reduced amount of No. 6 fuel oil (about 10 percent of past years' consumption) continues to be used (BNL 1995a).

Additional support facilities maintained at BNL include apartments, dormitories, the guest rooms building, cottages, mobile homes, efficiencies, an auditorium and cafeteria facility, a child care facility, a fire house with emergency and rescue equipment, and a new 7 ha (18 acre) state-of-the-art WMF to process BNL's radiological and hazardous waste (BNL 1995a).

3.4 AIR QUALITY/NOISE

3.4.1 BACKGROUND TO AIR QUALITY/NOISE

3.4.1.1 Definition of Resources and Approach

Air Quality: The assessment of air quality impacts considered the air pollutant emissions from normal HFBR facility operations associated with each alternative. Atmospheric dispersion of typical emissions from construction activities (for example, tritium plume investigation, engine exhaust, and fugitive dust emissions), operations, and maintenance activities were estimated using conventional modeling techniques. The estimated concentrations of these pollutants at the site boundary were compared with existing air quality standards for criteria pollutants or with guidelines for pollutants that do not have corresponding standards.

Air quality in a given location is described as the concentration of various pollutants in the atmosphere. Air quality is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions.

An area is designated by the EPA as being in "attainment" for a pollutant if ambient concentrations of that pollutant are below the National Ambient Air Quality Standards (NAAQS) (40 CFR 50) and "nonattainment" if violations of the NAAQS occur. In areas where insufficient data are available to determine attainment status, designations are listed as unclassified. Unclassified areas are treated as attainment areas for regulatory purposes.

Prevention of Significant Deterioration (PSD) is a regulation incorporated in the *Clean Air Act* (CAA) that limits increases of pollutants in clean air areas (attainment areas) to certain increments even though ambient air quality standards are being met. The PSD Program is implemented in large part through the use of increments and area classifications. The CAA area classification scheme for PSD establishes three classes of geographic areas and applies increments of different stringency to each class. Organizations planning construction or modifications to a facility that is located in an attainment area may be subject to PSD regulations if the facility is classified as a "major" source or "major" modification. A new source is major if it is one of the 28 listed sources and has the potential to emit more than 90,800 kg (100 tons) per year of a regulated pollutant or more than 227,000 kg (250 tons) per year of any air pollutant subject to regulation under the CAA, regardless of its source type. A modification is major if it will occur at an existing major source and will cause emission increases of regulated pollutants above "significant" emission rate levels defined in the regulations. Based on 40 CFR Part 52.21, major sources must first obtain a PSD permit for either a new facility or modifications from the state where the facility is located.

Noise: The assessment of noise impacts considered normal HFBR facility operations associated with each alternative.

Noise is defined as sound that is undesirable because it interferes with speech, communication, and hearing, is intense enough to damage hearing, or is otherwise annoying. The characteristics of sound include parameters such as amplitude, frequency, and duration. The decibel (dB), a logarithmic unit that accounts for the large variations in amplitude, is the accepted standard unit measurement of sound.

The day-night average sound level was developed to evaluate the total community noise environment. The day-night average sound level is the composite measure of noise during a 24-hour period with 10 dB added to nighttime levels (between 10 p.m. and 7 a.m.). This adjustment is added to account for the increased sensitivity to nighttime noise events. The day-night average sound level was endorsed by the EPA and is mandated by the U.S. Department of Housing and Urban Development, the Federal Aviation Administration, and the Department of Defense for land-use assessments.

The day-night average sound level is sometimes supplemented with another noise level measurement, the equivalent sound level. The equivalent sound level is the level of a steady-state sound that has the same sound energy as that contained in the time-varying sound being measured over a specific time period. The major noise sources at the HFBR include equipment and machines (for example, cooling tower, engines, pumps, paging systems, construction and material-handling equipment, and vehicles).

A background sound level of 30 dB is a reasonable conservative estimate for the surrounding area. This is consistent with other estimates of sound levels for rural areas. The rural communities day-night average sound level has been estimated in the range of 35 to 50 dB (EPA 1974). A background sound level of 50 dB (DOE 1994) is a reasonable estimate for the main BNL facility.

3.4.2 AFFECTED ENVIRONMENT

3.4.2.1 Air Quality

The regional air quality is a cross between maritime and continental influences from the Atlantic Ocean, Long Island Sound, and the various associated bays, resulting in the region and site being very well ventilated by winds from all directions (BNL 1996b).

The local air quality management in the New Jersey-New York-Connecticut Interstate Air Quality Control Region, which includes Suffolk County and BNL, is in attainment with most NAAQS for criteria pollutants, which include sulfur dioxide, nitrogen oxides, particulate matter, lead, and carbon monoxide. The county only exceeded the NAAQS for ozone (40 CFR 81).

The nearest significant source of hazardous or criteria pollutants is the New York City area, located approximately 100 km (60 mi) to the west. Based on the data collected and referenced in 40 CFR 81.333, Suffolk County is well within all applicable Federal and State ambient air quality standards, with the exception of ozone. Ozone is most likely high as a result of ultraviolet oxidation of hydrocarbons produced by vehicles.

The HFBR does not have any major or minor emission sources regulated under the New York State Air Pollution Control Regulations and the CAA. The site, similar to the region and most eastern seaboard areas, can be characterized as being a well-ventilated site. The prevailing ground level winds are from the southwest during the summer, from the northwest during the winter, and about equal from these two directions during the spring and fall (BNL 1996b).

3.4.2.2 Noise

In addition to the normal noises associated with industrial facilities and residential and commercial construction, transportation-related noise is a factor when considering the added regional impact from HFBR operations.

Major noise sources for the region include the three major airports serving Long Island. Long Island Islip MacArthur Airport, located in Ronkonkoma in the central portion of Long Island, offers scheduled flights through nine airlines. Over a million passengers pass through the 560 ha (1,400 acre) airport annually. Just over the Nassau border in adjacent Queens County are JFK International and LaGuardia Airports. Four additional airports located on Long Island feature full-service fixed-based operators and also serve executive and privately owned planes. They are Republic Airport in East Farmingdale, Francis S. Gabreski Airport in Westhampton Beach, Brookhaven Calabro Airport in Shirley, and East Hampton Airport.

Other sources of noise include the three major express routes that run east and west through Long Island. The LIE (Interstate Route 495) runs from New York City to Riverhead and is adjacent to the southern boundary of the site. The Northern State Parkway runs from Queens to Hauppauge and the Southern State Parkway runs from Brooklyn and Queens to Oakdale.

The LIRR, the nation's largest commuter railroad, operates 740 passenger trains daily on three major east-west routes from New York City along the entire length of the Nassau-Suffolk County region. With over 1,100 passenger cars and approximately 1,130 km (700 mi) of track, the LIRR services 134 stations in communities throughout Long Island and carries over a quarter million passengers daily. The railroad is located along the southern boundary of the site.

Noise generated at the HFBR does not propagate off of the site at audible levels much greater than the surrounding area for several reasons. First, the facility is located near the center of the site. Second, there is a large amount of wooded area near the BNL boundaries that acts as a buffer to reduce noise. The closest sensitive receptors to the site boundary would be residences located approximately 2.1 km (1.3 mi) to the west.

All HFBR alternatives would involve noise generation associated with interior construction to repair the spent fuel pool. The actual noise level will vary slightly depending on the distance between the work activities within the HFBR and the sensitive receptors such as residences, hospitals, and schools.

3.5 WATER RESOURCES

3.5.1 BACKGROUND TO WATER RESOURCES

3.5.1.1 Definition of Resources

Water resources include surface waters and groundwater potentially impacted by operation of the HFBR. Surface water includes freshwater bodies that occur above the surface of the ground, including rivers, streams, lakes, and human-created catchment basins (recharge basins). Groundwater resources are defined as the aquifers underlying the site and region.

3.5.1.2 Approach to Defining Environmental Setting

Surface water and groundwater resources at BNL were evaluated using a variety of existing site-specific and regional documents, as well as through communications with BNL personnel. Information on regional aquifers and local groundwater quality was obtained from U.S. Geological Survey (USGS) documents and numerous reports on the site prepared under the CERCLA program. Reports on water usage and discharges during past operation of the HFBR were also reviewed. This information was used to describe current conditions and to evaluate potential impacts to surface water and groundwater under the proposed alternatives.

3.5.2 AFFECTED ENVIRONMENT

3.5.2.1 Surface Water

Streams and Ponds: BNL is located entirely within the Peconic River watershed. The Peconic River is a low-gradient stream that has a relatively undeveloped watershed. It is the largest groundwater-fed river in New York and the longest river on Long Island. The western headwaters of the Peconic River originate approximately 1.2 km (0.75 mi) west of the site and the river flows east to Peconic Bay. This river was designated as a Scenic and Recreational River by the State of New York in 1986 because it represents the last significant undeveloped river within the Long Island Pine Barrens area. Stream flow in the Peconic River is heavily influenced by groundwater level, with discharge of groundwater through the stream bed during periods of high rainfall, and infiltration of stream flow into the stream bed during periods of low rainfall (BNL 1996b).

A branch of the Peconic River headwaters enters the BNL property in the northwest portion of the site. The river exits the site to the southeast near North Street. Within the site boundaries, the Peconic River is an intermittent stream and typically has little or no flow. Offsite flow occurs during periods of sustained precipitation, typically in the spring (BNL 1999). The start of flow for the Peconic is typically to the east (downstream) of the site boundary. The BNL STP has a SPDES permitted discharge on the Peconic River approximately 2,400 m (1.5 mi) upstream of where the river exits the site (SPDES Permit # NY 0005835, Outfall 001, Location EA). This outfall receives wastewater from the HFBR, and is discussed in further detail in Section 3.5.2.3. The only natural pond onsite is Zeeks Pond located along the eastern site boundary (LMS 1995).

Recharge Basins: BNL maintains seven recharge basins (see Figure 3.5–1), which are permitted under SPDES, for the discharge of process cooling waters, stormwater runoff, and water-filter backwash from the Water Treatment Plant (BNL 1996b). Water entering the recharge basins infiltrates back into groundwater, replenishing the underlying aquifers. Recharge Basin HO (Outfall 003) receives secondary cooling water discharge from the HFBR and is discussed in further detail in Section 3.5.2.3.

3.5.2.2 Groundwater

The following sections describe the configuration of the aquifers and confining units that comprise the groundwater systems in the vicinity of BNL. Aquifers located on Long Island are classified as Sole Source (Class I) aquifers by the EPA (42 USC 300h-3(e)) and as Class GA (potable water) by NYSDEC. Groundwater is the sole source of potable water for Suffolk County residents. Long Island's groundwater reserve originates from precipitation percolating downward to the underlying aquifers. Approximately 85 percent of County residents obtain their potable water from private water supply companies; the remaining population is served by individual private wells (USGS 1997).

The hydrogeology in the vicinity of BNL consists of approximately 460 m (1,500 ft) of unconsolidated sediment overlying bedrock. These unconsolidated deposits are described below in descending order (Figure 3.5-2).

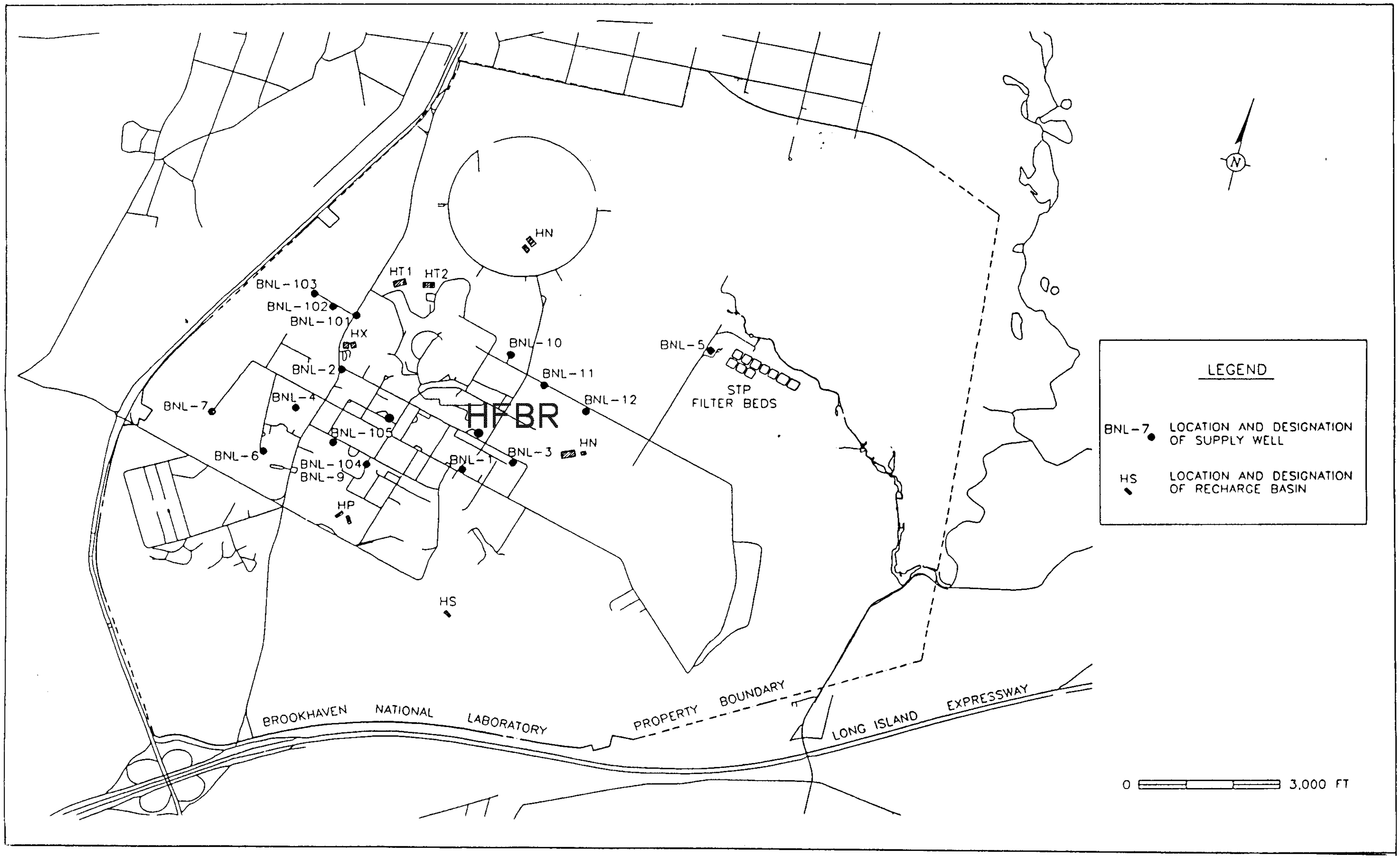
Upper Glacial Aquifer: The Upper Glacial Aquifer is of Pleistocene age and is present throughout the majority of Suffolk County. The Pleistocene sediments were deposited in a glaciofluvial environment during the Wisconsin glaciation. It is a shallow aquifer composed of outwash deposits of sand (fine to coarse) and gravel (pebble to boulder size) having a total thickness of as much as 210 m (700 ft). Terminal moraines, such as the Harbor Hill and Ronkonkoma, are composed of till which consists of clay, sand, gravel, and boulders. Till deposits are poor aquifers and yield very little water. However, the outwash deposits are moderately to highly permeable. Average horizontal hydraulic conductivity in the outwash deposits are reported to be approximately 82 m/d (270 ft/d) (USGS 1989). At BNL, the Upper Glacial deposits range in thickness from approximately 30 m to 60 m (100 ft to 200 ft) (de Laguna 1963). All currently operating supply/potable wells at the site are screened in the Upper Glacial Aquifer (that is, the wells draw water from the Upper Glacial Aquifer), as are residential wells located south (downgradient) of BNL.

Gardiners Clay: The Gardiners Clay is of Pleistocene age and rests unconformably below the Upper Glacial Aquifer. ("Unconformably" is a term used to describe a layer that is not continuous, or is interrupted by other layers.) The unit contains as much as 46 m (150 ft) of variable amounts of massive green clay, silty, sandy, and gravelly green clay, clayey silt, and sand. The Gardiners Clay, where present, constitutes a confining layer between the Upper Glacial and the underlying Magothy Aquifer. Average vertical hydraulic conductivity is reported to be approximately 0.0003 m/d (0.001 ft/d) (USGS 1989), indicating that this unit is fairly impermeable. The Gardiners Clay is discontinuously present beneath BNL.

Magothy Aquifer: In the vicinity of BNL, the Magothy Aquifer lies unconformably under Pleistocene deposits (Upper Glacial Aquifer and Gardiners Clay, where they exist). The Magothy Aquifer is of Upper Cretaceous age consisting of a maximum of 340 m (1,100 ft) of sand (fine to medium) interbedded with lenses and layers of coarse sand, and sandy and solid clay. Gravel is common in the basal or lower zone of the unit. The depositional environment of the Magothy Aquifer was dominated by streams and coalescing deltas (USGS 1989). The surface configuration of the Magothy Aquifer reflects the historic severe erosion that occurred during several episodes of Pleistocene glaciation which shaped Long Island. At the site itself, the thickness of the Magothy Aquifer ranges from approximately 240 m to 270 m (780 ft to 890 ft) (de Laguna 1963).

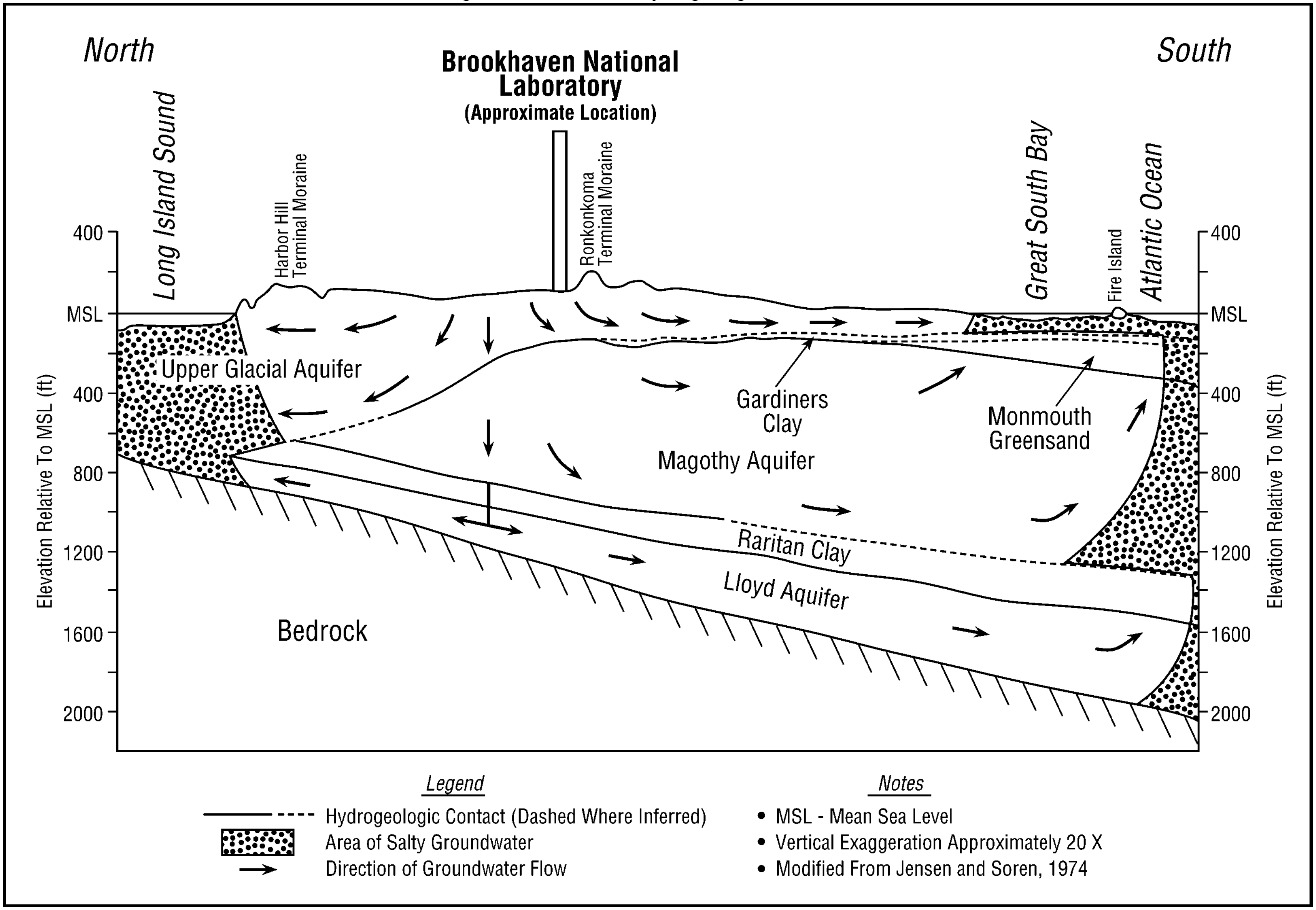
Within the Magothy Aquifer's appreciable thickness, massive clay layers exist at varying depths and reflect the highly stratified character of this aquifer. Of particular importance is a massive locally continuous primarily gray-brown clay layer encountered within the upper portion of the Magothy Aquifer. This unit ranges in thickness from 1.5 m (5 ft) to greater than 23 m (75 ft). Based on a review of available onsite and offsite well logs, this unit (referred to in this EIS as the Magothy "gray-brown" clay) is interpreted to be laterally continuous in an east-west direction through the central portion of the site and to extend south offsite. The Magothy "gray-brown" clay is typically found at the top of the Magothy Aquifer and acts as a confining unit slowing the vertical flow of groundwater between the Upper Glacial and Magothy Aquifers. In other areas, the top of this unit is encountered within the upper 3 m to 12 m (10 ft to 40 ft) of the Magothy Aquifer.

Figure 3.5-1. Location of Supply Wells and Recharge Basins.



Source: BNL 1997b.

Figure 3.5-2. General Hydrogeologic Cross-Section.



Source: BNL 1997b.

Most layers within the Magothy Aquifer are poorly to moderately permeable with some highly permeable layers occurring locally. The Magothy Aquifer is a principal aquifer for potable water in Suffolk County. The average horizontal hydraulic conductivity of this aquifer is reported to be approximately 15 m/d (50 ft/d) (USGS 1989).

Raritan Clay: The Raritan Clay lies under the Magothy Aquifer and is approximately 60 m (200 ft) thick beneath the site. The Raritan Clay is comprised of tough dark gray or black lignitic clay, with some light silty and sandy clay, and lenses of sand and gravel (de Laguna 1963). The Raritan Clay is a very poorly permeable unit that acts as a confining unit between the Magothy Aquifer and the underlying Lloyd Aquifer. The reported average vertical hydraulic conductivity is approximately 0.0003 m/d (0.001 ft/d) (USGS 1989).

Lloyd Aquifer: The Lloyd Aquifer lies under the Raritan Clay and directly over the bedrock. The Lloyd Aquifer is approximately 90 m (300 ft) thick in the vicinity of the site. It consists predominantly of coarse to fine sands with some quartz gravel and soft clay. Beds of clay, fine sand, and sandy clay have been documented (de Laguna 1963). The aquifer is poorly to moderately permeable and the water is confined. The average horizontal hydraulic conductivity is approximately 12 m/d (40 ft/d) (USGS 1989).

Bedrock: The bedrock beneath Suffolk County is of Paleozoic and Precambrian age, and consists of crystalline metamorphic and igneous rocks like muscovite-biotite, schist, gneiss, and granite. A soft clayey zone of weathered bedrock separates the Lloyd Aquifer from solid bedrock, locally found to be approximately 21 m (70 ft) thick. The bedrock has insignificant water transport activities and varies from 150 m to 550 m (500 ft to 1,800 ft) below grade in Suffolk County (USGS 1989). Two deep USGS exploratory wells encountered bedrock at approximately 500 m (1,600 ft) below land surface at BNL (de Laguna 1963).

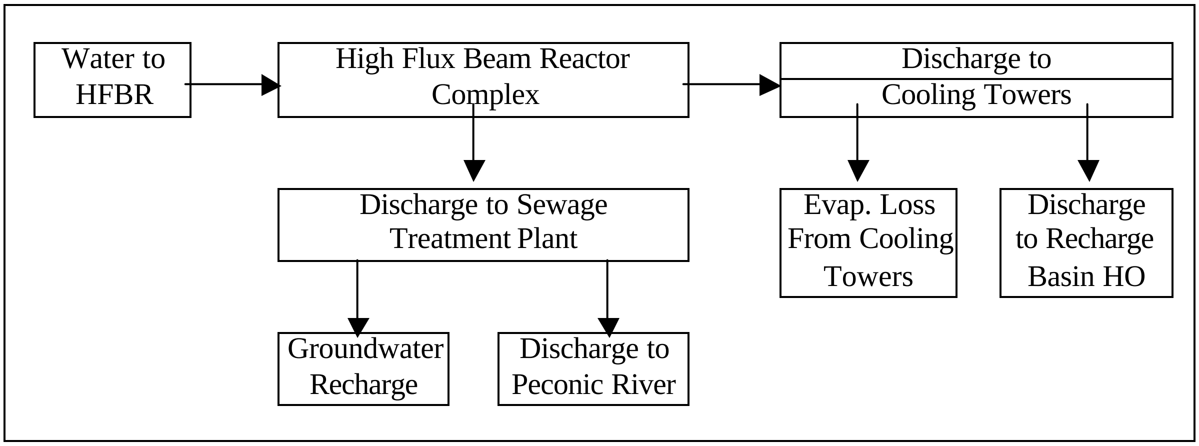
3.5.2.3 HFBR Water Usage

The BNL water supply and distribution system for the site consists of a water treatment plant, two elevated storage tanks, twelve supply/potable water wells (#1 through #12), five process wells, and a piping distribution network connecting components with buildings. The HFBR currently obtains water from onsite supply wells #4, 6, 7, 10, 11, and 12, all of which withdraw from the Upper Glacial Aquifer (see Figure 3.5-1). Figure 3.5-3 provides an overview of how water is used at the HFBR and what surface water and groundwater discharges result from its operation. As shown in Figure 3.5–3, there are two primary discharges to surface water and groundwater: (1) discharge to the Peconic River via the STP; and (2) discharge to Recharge Basin HO via the cooling towers. Each of these discharges is discussed below.

Wastewater from the HFBR is discharged to the STP, which discharges to the Peconic River via a SPDES permitted outfall. The discharge from the HFBR to the Peconic River via the STP currently is estimated to be 0.15 MLD (40,000 GPD) (Ports 1998a). The primary effluent of concern in wastewater from the HFBR is tritium. As noted in Section 3.11.2.2, no activity at the HFBR was found to use non-radiological chemicals in quantities that may pose substantial risks to humans or the environment. Even though the HFBR is not operational, tritium is present in the sanitary system (which is functioning and being used) under current conditions. Maintenance activities and fugitive emissions from facility components result in low levels of airborne tritium vapor within the HFBR confinement. The vapor can come in contact with water being discharged to the sanitary system resulting in some tritium contamination of the liquid effluent (BNL 1996b).

BNL monitors radiological parameters at the outfall to the Peconic River from the STP in accordance with DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. The outfall is analyzed daily for tritium. Under the *Safe Drinking Water Act* (SDWA), the

Figure 3.5-3. HFBR Water Use During Operation.



tritium concentration in drinking water must not exceed 20,000 pCi/l. The NYSDEC has adopted the same standard. In 1997, the most recent year for which the *Site Environmental Report* has been prepared, the annual average tritium concentration in the STP Peconic River outfall was 1,366 pCi/l or 7 percent of the drinking water standard (BNL 1999). This continues a trend of annual average tritium concentrations below 20,000 pCi/l that has existed since 1987 (BNL 1996b). It should be noted that although drinking water standards are used for comparison purposes in the *Site Environmental Report* and this EIS, the Peconic River is not used as a source of potable water.

When the facility was operating, secondary cooling water from the cooling towers was discharged to Recharge Basin HO under a SPDES permit. As is the case with the discharge to the Peconic River, the primary chemical of concern in this discharge was tritium. Non-radiological chemicals were added for cooling water chemistry control, and were monitored under the SPDES permit at Recharge Basin HO. As noted in Section 3.11.2.2, the use of these chemicals did not pose substantial risks to humans or the environment. Since the facility is not operational, there is currently no flow to the cooling towers.

3.5.2.4 Site Groundwater Quality

Past operations at BNL have impacted water resources. Discovery of site contamination led to BNL being listed a National Priorities List (NPL) Superfund site. In response, DOE entered into an Interagency Agreement with the EPA and NYSDEC. BNL's Superfund cleanup program is organized into six administrative segments, or Operable Units (OUs), each representing a geographic area of the site (Figure 3.5-4). OU I and OU VI have been combined operationally. Soil and groundwater in the OUs are being investigated to determine if past site activities have left residual contamination with the potential to impact human health or the environment. BNL is continuing to work with Federal, State, and local officials, and the public, to determine the appropriate steps for remediation.

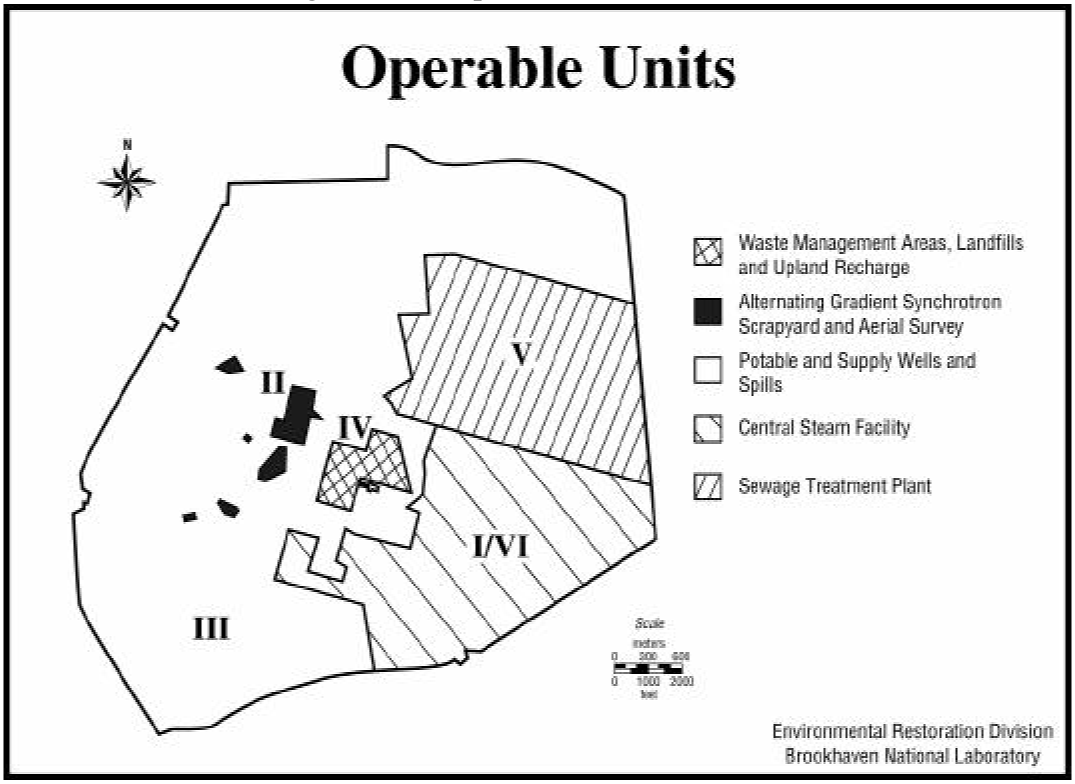
An overview of CERCLA activities with respect to groundwater chemical plumes is provided in the following section. These chemical plumes are not due to historic HFBR activities but are included to provide site background information. HFBR-related groundwater issues, especially the tritium plume, are discussed in Section 3.5.2.4.2.

3.5.2.4.1 *Overview of CERCLA Investigations*

The six OUs (shown in Figure 3.5–4) at BNL are known as follows:

- OU I – Former Hazardous Waste Management Facility (HWMF), Current Landfill area, and Former Landfill area

Figure 3.5-4. Operable Units Boundaries.



- OU II - Waste concentration facility, AGS scrap yards, former Low-Mass Criticality Facility, contaminated landscape soils

- OU III - HFBR tritium contamination, potable/supply wells, chemical spills, sewer pipes (in the central area)

- OU IV - Central Steam Facility, reclamation facility

- OU V - Contamination related to the STP

- OU VI - Ethylene dibromide (EDB) groundwater contamination

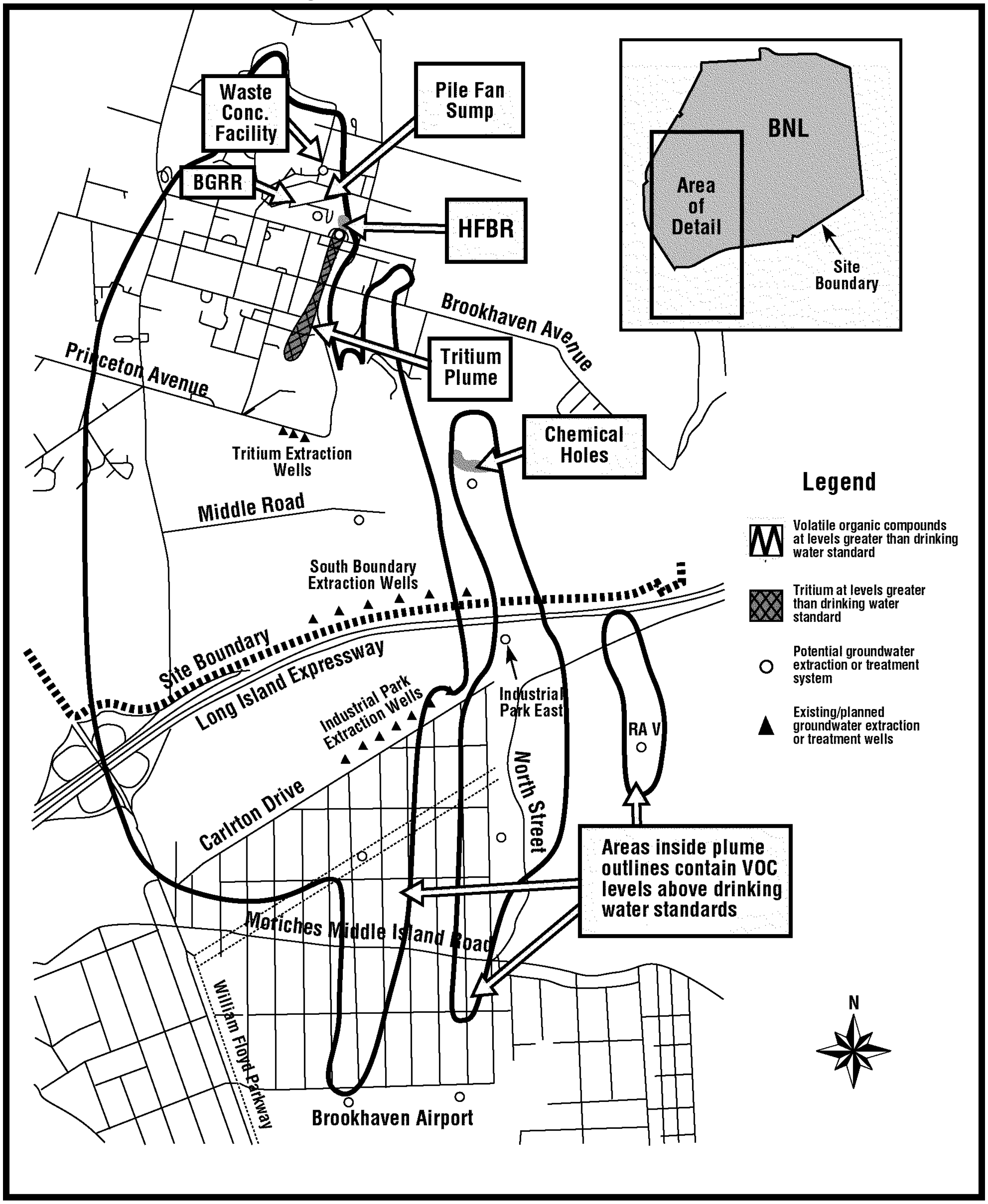
The tritium contamination related to previous operation of the HFBR is associated only with OU III and OU V.

To streamline the remedial investigation/ feasibility study (RI/FS) process, the OUs have been grouped and joint RI/FSs performed. Based on the RI/FS data collected to date, groundwater chemical plumes emanating from the various OUs have been defined (See Figure 3.5–5). The defined chemical plumes and remedial activities underway for each of the OUs are summarized below.

OU I/IV Chemical Plumes: OU I/IV is the administrative name given to about 525 ha (1,300 acres) of BNL's mostly wooded southeastern area. About 16 ha (40 acres) of OU I have historically been used as a waste handling area for BNL, including chemical/animal/glass disposal pits (now closed) and the former HWMF.

Based on samples collected at 340 locations, three groundwater chemical plumes have been defined within OU I/IV boundaries: a plume identified with the Former Landfill Area and animal/chemical pits, the OU IV-Volatile Organic Compound (VOC) plume associated

Figure 3.5-5. Tritium and VOC Plumes.



with the Central Steam Facility, and the Current Landfill/Former HWMF plume. The OU IV-VOC plume associated with the Central Steam Facility has merged with the OU III chemical plume and will be discussed below with the OU III plume. The Former Landfill and animal/chemical pits chemical plume is generally located offsite and is sandwiched between the OU III (OU IV-VOC) and the Current Landfill/Former HWMF plumes. This elongated plume extends from the south-central BNL area to just south of Middle Island Road, and is approximately 3.1 km (1.9 mi) long by 0.5 km (0.3 mi) wide. Within this chemical plume there appears to be two areas of elevated VOCs, one near its center and the other near its southern edge (BNL 1996c). The Current Landfill/ Former HWMF plume extends south from the Current Landfill and the former HWMF, which are located in the south-central section of the BNL facility. The plume is approximately 1.9 km (1.2 mi) long and extends offsite south of the LIE. The groundwater contaminants within OU I can be traced back to specific source areas. The characteristic contaminants include: tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (TCA), and chloroform from the Former Landfill; TCA, PCE, and carbon tetrachloride from the chemical/animal disposal pits; and TCA, 1,1-dichloroethane (DCA), and chloroethane from the Current Landfill. The groundwater contamination associated with OU IV includes cis-1,2-dichloroethene (cis-1,2-DCE), TCE, and PCE. The sources of contaminants detected in OU IV are from the Central Steam Facility area (BNL 1996c). Waste handling or historic use of solvents associated with the steam facility resulted in chemicals discharging to groundwater. Previous remedial activities at this area include tank removal and removal of contaminated soils. A soil and groundwater treatment system was installed as a final remedy.

OU III Chemical Plume: OU III is the administrative name given to about 850 ha (2,100 acres) of BNL's central and western area. Based on extensive field sampling, a plume of VOC-contaminated groundwater has been defined within OU III. The plume, resulting from multiple sources that have mingled due to pumpage and recharge effects, extends from the central portion of BNL approximately 5 km (3 mi) to the south-southeast in the direction of groundwater flow. The maximum width of plume is approximately 2.4 km (1.5 mi) near BNL's southern boundary (including the OU IV-VOC plume). Vertically, a majority of the plume is within the upper Glacial Aquifer. As the plume migrates south of the BNL property line, it has been found to enter the Upper Magothy Aquifer where the gray-brown clay is absent. In general, the OU III chemical plume migrates deeper into the aquifer system the further it moves downgradient. Residential wells located south of BNL typically draw water from the shallow portions of the Upper Glacial Aquifer; therefore, the portion of the chemical plume which has migrated offsite is at a depth that is below residential wells (BNL 1997c). Although current groundwater monitoring data show that the OU III VOC contamination is located at depths generally below residential wells, DOE has extended the public water system to the potentially affected communities south of the BNL site boundary. This action was taken as a precautionary measure to prevent any potential future exposure to groundwater contaminants associated with Operable Unit III.

Nine VOCs have been detected in the plume. These include: carbon tetrachloride, chloroform, 1,1-dichloroethene (DCE), 1,1,2,2-tetrachloroethane (PCA), PCE, toluene, TCA, TCE, and xylenes. Of these nine compounds, four (carbon tetrachloride, PCE, TCE, TCA) exhibited consistent elevated levels above drinking water standards and have been identified as the primary VOCs (BNL 1997c).

The sources of the OU III VOC plume were identified as follows:

- Building 96 area (warehouse)
- Supply and Material Area (Building 208)
- Paint Shop
- AGS Complex

Because contaminants were detected offsite, DOE decided to conduct an Interim Remedial Measure (IRM) for groundwater contaminants within OU III at BNL. The IRM includes removal activities which consist of the installation of six extraction wells that have the capacity to pump a total of approximately 2,500 lpm (650 gpm) from the aquifer. The collected groundwater is piped to a treatment facility, where the VOCs are removed. The clean water is released to a recharge basin located approximately one mile north of the site's southern boundary, and the VOCs are discharged to the air under a NYSDEC equivalency permit. The removal activities are being carried out prior to the completion of the remedial investigation to prevent further migration of contaminated groundwater into areas south of the site boundary.

OU V Plume: The STP plume (OU V), as defined by the 5 μg/l concentration contour line, extends from a location southeast of the STP onsite to the LIE offsite (approximately 1,850 m [6,000 ft]). The plume is approximately 610 m (2,000 ft) in width. The STP plume consists primarily of TCE with a maximum observed concentration of 21 μg/l. Low concentrations of toluene (less than 4 μg/l) were also detected in several offsite wells. In 1997, a number of OU V wells were analyzed for Target Analyte List (TAL) metals and pesticides/PCBs. No metals, including mercury and hexavalent chromium, were detected above NYS Ambient Water Quality Standards in these samples. Of the groundwater samples from offsite wells that were analyzed for pesticides/PCBs, only a trace amount (0.009 μg/l) of 4,4-DDT was detected.

Additionally, results of the OU V groundwater sampling indicated that tritium was present in groundwater in the OU V plume, however the detected concentrations are significantly less than the SDWA level for tritium. The highest detected tritium concentration was 2,280 pCi/l, which is almost one order of magnitude less (or, ten times less) than the SDWA level of 20,000 pCi/l (BNL 1998d). This tritium resulted from past low-level and unplanned releases to the STP. (This tritium should not be confused with the tritium plume associated with the HFBR Spent Fuel Pool discussed in Section 3.5.2.4.2.)

As part of an ongoing environmental investigation of the Peconic River area, BNL recently sampled Peconic River sediments. The plutonium analyses performed on Peconic River sediment samples collected in the spring of 1998 yielded inconclusive results (that is, the instruments and techniques used were not sufficiently sensitive to confirm or deny the presence of plutonium in the sediment samples). Therefore, the sampling and analysis plan titled *Plutonium Contamination Characterization* was prepared in order to more accurately determine the presence of plutonium (not related to background plutonium from weapons-testing) in the river sediments. The final results are expected in the fall of 1999. Also, DOE is addressing this issue through the CERCLA process and an Interagency Agreement with the EPA and NYSDEC.

OU VI Chemical Plume: OU VI is an area located in the southeastern section of BNL. This area is relatively undeveloped and was historically used for agriculture research. Groundwater in the area just south of the research area contains concentrations of EDB above the NYS drinking water standard of 0.05 μg/l. This contamination originated from EDB that was used to sterilize soils in agricultural experiments in the 1970s (BNL 1996d).

Well samples taken by the SCDHS and BNL showed that EDB had leached into groundwater and traveled southeast. The plume is approximately 1.6 km (1 mi) in length and has a maximum width of 0.7 km (0.4 mi) (BNL 1996d). In 1997, the highest EDB concentration of 1.48 μg/l was observed in an offsite well located south of the LIE. A semi-annual monitoring program was initiated in June 1997 and will be continued as specified in the OU VI ROD.

All homes within the vicinity of the potential EDB contamination have been provided with public water hookups. A groundwater-monitoring program will evaluate the migration and progress of the natural attenuation of the EDB plume.

3.5.2.4.2 *HFBR Related Groundwater Issues – Tritium Plume*

In October 1996, tritium (approximately 2,000 pCi/l) was detected in two new groundwater monitoring wells installed adjacent to the HFBR Building. Background tritium concentrations, due to atmospheric testing of nuclear arms, in onsite supply and process wells is less than 375 pCi/l. Subsequent sampling carried out in January 1997 revealed tritium concentrations in excess of the drinking water standard of 20,000 pCi/l (BNL 1998e). Subsequent Geoprobe™ sampling revealed a tritium concentration of 660,400 pCi/l in a sample collected just south of the HFBR. The highest concentration detected in a permanent onsite monitoring well was 1,590,000 pCi/l.

In response, DOE and BNL established a Tritium Remediation Project (TRP) at BNL in the spring of 1997 to implement an interim accelerated response to ensure the protection of public health and the environment. The interim response included well drilling, tritium sampling, engineering evaluations, and groundwater modeling in an effort to streamline and coordinate field and engineering activities. After completion of the initial investigation, the TRP has been merged into the OU III RI/FS (BNL 1998e).

Investigation into the source of the tritium plume was a major focus of the TRP. On the basis of the following data, BNL concluded that the HFBR Building was the primary source of the tritium (BNL 1998e):

- The results of groundwater sampling indicated high tritium concentrations downgradient of the HFBR building.
- Significant contamination was detected near the top of the aquifer in the immediate vicinity of the HFBR building, suggesting a nearby source.
- No unusual levels of tritium were detected outside the groundwater flow path from the HFBR building.

Once the HFBR building was identified as the primary source, systems that managed radioactive fluids or had the potential to come into contact with radioactive or tritiated fluids were examined. The evaluation process identified the spent fuel pool as the primary source, which was confirmed with two leak tests that revealed a leak rate of 23 lpd to 34 lpd (6 GPD to 9 GPD). Additionally, the plume characteristics were consistent with a long term continuous leak from the spent fuel pool based on the tritium concentration of the pool water. The sanitary sewer line going to the STP was identified as a potential secondary tritium source (BNL 1998e).

The combined sampling and monitoring results have defined the tritium plume. The plume is located entirely within the boundaries of BNL (see Figure 3.5–5), with the portion exceeding the SDWA tritium standard of 20,000 pCi/l extending approximately 800 m (2,600 ft) south of the HFBR. The highest concentration of tritium was detected immediately south of the HFBR building (1,590,000 pCi/l) and concentrations decrease to 6,440 pCi/l approximately 1,100 m (3,600 ft) south. Currently the leading edge of the 20,000 pCi/l portion of the plume is approximately 1,500 m (4,800 ft) north of the BNL southern boundary. Tritium concentrations at the leading edge of the plume are less than 1,000 pCi/l. At the average groundwater velocity of 0.25 m/d (0.8 ft/d), it will take groundwater at the leading edge 16 years to reach the boundary. In that time, natural radioactive decay alone will reduce the tritium concentration to less than one-half of its current level. Therefore, even without remediation, model simulations have shown the HFBR tritium plume should never cross the BNL boundary in excess of drinking water standards (BNL 1998e).

Source Evaluation: In 1997, the HFBR Complex and its associated processes, facilities and exterior grounds were evaluated to identify potential sources of tritium to the environment. Potential sources associated with the HFBR are discussed below:

The HFBR Spent Fuel Pool: As discussed above, the spent fuel pool was identified as the source of tritium to the tritium plume. The leakage rate was estimated at 23 lpd to 34 lpd (6 GPD to 9 GPD).

HFBR Building Equipment Level Leaks and Spills: There have been several leaks and spills of tritium contaminated water, including a primary coolant leak which occurred in July 1995. Tritiated waste materials may have leaked to the ground beneath the reactor through seams, cracks and floor penetrations.

The HFBR Secondary Cooling Water System. The Tritium Remediation Project study eliminated the Secondary Cooling Water System as a potential source of the tritium plume based on the nominal tritium concentration (1,100 pCi/ℓ) in the secondary cooling water. However, the presence of tritium in the secondary water warranted further investigation. During normal system operation, the pressure on the heavy water side of the heat exchangers is maintained higher than the pressure on the secondary side. A leak in the heat exchanger tubes could therefore lead to contamination of the secondary water system. Leak tests of the system have shown that the leakage rate from the primary heat exchanger is approximately 0.5 ml/day (0.017 fl oz/d, or 1/10th of a measured teaspoon) and from the shutdown heat exchanger is approximately 0.008 ml/day (0.0003 fl oz/d) (BNL 1998f).

HFBR Sanitary System: Portions of the BNL sanitary system external to the HFBR building were eliminated as a potential source because the nominal discharge tritium concentration was insufficient to result in the observed plume. However, historically discrete sources of tritiated water, primarily from the air conditioning system, were introduced to the sanitary system within the HFBR confinement building. Therefore, leakage from below-grade portions of the system in areas receiving higher concentrations of tritiated water may have contributed to the plume. A leak test conducted in November 1997 showed a loss rate of approximately 15 ℓpd to 26 ℓpd (4 GPD to 7 GPD), indicating that the below-grade sanitary piping is in reasonably good condition and confirming that it could not be a major contributor to the existing tritium contamination (BNL 1998e). While the leak rate from the sanitary system sewer line appears comparable to the former leak from the spent fuel pool (23 ℓpd to 34 ℓpd [6 GPD to 9 GPD]), the average annual tritium concentrations are extremely different. In 1996, the average annual tritium concentration at the discharge from the HFBR sanitary system was about 7,100 picocuries/ℓ (pCi/ℓ). This concentration is about one-third of the Safe Drinking Water Act (SDWA) standard of 20,000 pCi/ℓ that is established by the EPA for protection of human health. The average spent fuel pool tritium concentration was about 40,000,000 pCi/ℓ, with a noted increase to 140,000,000 pCi/ℓ in 1995. Following further inspections and repairs, additional leak testing of the sanitary system is planned to ensure that the sanitary system integrity satisfies Suffolk County Department of Health Services building and sanitary code requirements.

Remedial Activities: DOE has implemented, or is implementing the following remedial activities (BNL 1998e):

- Removal of spent fuel from the spent fuel pool in preparation for the installation of a stainless steel liner
- Removal of approximately 250,000 ℓ 65,000 gal) of water from the spent fuel pool, which is now being stored onsite in temporary storage tanks
- Elimination of other potential sources of groundwater contamination
- Groundwater pumping at the leading edge of the plume

Each of these activities is described below.

Spent Fuel Pool Liner: The spent fuel elements have been removed from the spent fuel pool and shipped offsite, and the spent fuel pool has been drained to stop the leakage of contaminated water. To eliminate the spent fuel pool as a source of future groundwater contamination, an impervious double-walled stainless steel liner with appurtenant piping, and leak detection systems will be installed in conformance with Suffolk County Sanitary Code, Articles 7 and 12 (BNL 1998f).

Other Sources of Groundwater Contamination: In order to address other potential sources of leakage from the HFBR, several piping systems and sumps will be modified and repaired. Single-walled piping and sumps will be replaced with double-walled components, or new components will be installed above the floor. Seals around all penetrations and construction joints on the HFBR building equipment level floor are being repaired and sealed. These modifications will meet the requirements of Suffolk County Sanitary Code, Articles 7 and 12 and are discussed in Section 2.3.

With regard to the secondary cooling water system, the average tritium concentration over the past 10 years has been approximately 1,100 pCi/l (approximately 5.5 percent of the drinking water standard). During normal operation, a small amount (approximately 0.5 ml/day) of tritiated coolant is introduced to the secondary water cooling system in the heat exchangers. The leak (migration) rate has not measurably changed over 17 years. No significant environmental impact would result from system operation in the current status. If DOE decides to restart the HFBR, program and equipment changes would be made as necessary to assure that future operation would continue to be accomplished within all regulatory requirements, that ALARA criteria would be satisfied and that routine operations would not result in a significant environmental impact.

As discussed above, it has been determined that the sanitary system piping under the HFBR building is not a major source of tritium to groundwater (BNL 1998e). The major source of tritium to the sanitary system in the past (that is, the air conditioning condensate from the operational and equipment levels) is no longer discharged to the sanitary system. Further leak testing of the sanitary system is planned to more accurately assess the leakage rate. BNL will ensure that the sanitary system integrity satisfies SCDHS building and sanitary code requirements.

Groundwater Extraction System: BNL began operating an interim pump-and-recharge system to intercept the tritium plume in May 1997. The system is designed to ensure that tritium concentrations above the EPA drinking water standard of 20,000 pCi/l will not leave the BNL site. The groundwater extraction system provides a level of redundancy because current understanding of the tritium plume and groundwater flow indicates that tritium concentrations greater than the drinking water standard will never cross the BNL boundary from the HFBR tritium plume due to natural decay and dilution (BNL 1998e).

Three extraction wells were installed approximately 1,100 m (3,500 ft) south of the HFBR near Princeton Avenue in an area where the maximum tritium concentration was 6,440 pCi/l. Groundwater is pumped (approximately 454 lpm [120 gpm]) from a depth of about 45 m (150 ft) below land surface and piped 1,000 m (3,300 ft) northward to an existing recharge basin (RA V) within BNL and discharged under NYSDEC permit equivalency conditions. Prior to discharge into the recharge basin, the collected groundwater passes through activated carbon to remove chemical contamination (chiefly VOCs) that is also present in the collected groundwater due to other past BNL activities not associated with the HFBR. Tritium is not removed by the activated carbon and the maximum tritium concentration entering the infiltration basin historically was 1,800 pCi/l, and it is currently below detection limits (Hauptman 1998). Samples are analyzed on a regular basis to determine the tritium concentrations being recharged. Evaporation of tritiated water from the infiltration basin has been measured, and has been shown not to pose a risk to human health or the environment. Air monitoring stations continue to measure tritium concentrations in air on a regular basis (BNL 1998e).

Once the water has been recharged, it flows southward and takes approximately 19 years to reach the BNL site boundary. By that time, natural decay (the half-life of tritium is 12.3 years) and dilution will have reduced tritium levels to nearly undetectable levels. Monitoring wells located at the BNL boundary will provide advance warning should tritium concentrations exceeding the drinking water standards come near the boundary of the site (BNL 1998e). In response to other groundwater plumes (from OU III and VI), DOE had previously installed public water to the residences and businesses downgradient of the site.

The pump-and-recharge remediation is being conducted as an interim remedial action to ensure that tritium concentrations above the drinking water standards does not migrate across the BNL boundary. It also gives BNL and DOE time to study alternative remediation technologies and prepare a plan to address the high levels of tritium found immediately south of the HFBR. The long-term remediation of the plume will be determined in the OU III ROD (BNL 1998e).

3.6 GEOLOGY/SEISMICITY

Information on the geology and soil resources and seismicity was derived from the most recent and applicable reports, aerial photographs, and other literature (for example, EAs, EISs, and facility plans). Additional sources of information include: DOE, Bureau of Land Management (BLM), Minerals Management Service, EPA, USGS, and the Soil Conservation Service.

3.6.1 BACKGROUND TO GEOLOGY/SEISMICITY

3.6.1.1 Definition of Resources

Geologic resources are consolidated or unconsolidated earth materials, including mineral assets such as ore and aggregate materials, fossil fuels, and significant landforms. Soil resources are the loose surface materials of the earth in which plants grow, usually consisting of disintegrated rock, organic matter, and soluble salts.

Seismicity is not considered a resource. A discussion on the seismicity of the region is included in this section due to its relevance to the geologic environment and any potential effects to the proposed action and alternatives.

3.6.1.2 Approach to Defining the Environmental Setting

The ROI for geologic and soil resources comprises all areas subject to physical disturbance by construction and operational activities associated with an alternative. The physical setting and geology setting are described. The geology and soil resources were considered both with respect to the identification of those portions of the resource that could be affected by the alternative and the presence of natural conditions that may affect the alternative. Geology and soil conditions that may affect the integrity and safety of the proposed alternatives are a primary consideration. Specific geologic considerations which may be applicable include seismic activity (vibratory ground motion), and unique geologic resources. Specific soil considerations include suitability of soil for construction, soil quality for plant growth, and erosion.

Earthquake potential was evaluated based on the frequency, magnitude, and intensity of past events, the location and distribution of epicenters, and the location of capable faults as defined in 10 CFR 100, Appendix A. Areas of past mass movements (landslides and other forms of material transport) and conditions favorable for future mass movement were identified, including, landslide-susceptible rock and soil materials, and excessive slopes.

3.6.2 AFFECTED ENVIRONMENT

BNL, and Long Island in general, is located in a region which represents the furthest progress of the last two glaciers which covered this part of New York and New Jersey. BNL is in the upper part of the Peconic River Valley, which is bordered by two lines of low hills. These hills extend east and west beyond the limits of the valley nearly the full length of Long Island and form its most prominent topographic features. The northern line of hills, known as the Harbor Hill moraine, lies along the north shore, and the southern line, the Ronkonkoma moraine, extends along the center of Long Island and passes just south of BNL.

Just west of BNL, the two moraines are connected by a narrow north-south ridge, for which the hamlet of Ridge is named. East of this ridge is the Manorville basin; the main BNL grounds are on the basin's relatively high west margin. It is partly enclosed on the east, by Bald Hill, so that the surface drainage of the Manorville basin is poor, and much of the land near the river is swampy. West of the north-south ridge is the narrow, straight valley of the Carmans River. To the east, along the south margin of the Harbor Hill moraine, are two large kettle holes, Long Pond and Deep Pond.

South of the Ronkonkoma moraine is a comparatively flat featureless plain of irregular width. The principal irregularities of the plain south of BNL are the valleys of the Carmans River, which heads north of the moraine, and the much shorter Forge River, which heads in the Ronkonkoma moraine just south and southeast of BNL.

Between the mouths of the Carmans and the Forge Rivers, the south shore bays are divided by a wide tongue of land extending nearly across to the Great South Beach, commonly called Smith Point County Park. To the east is Moriches Bay; to the west is Great South Bay. The bays are bordered on the south by a long narrow line of barrier beaches.

The north shore of central Suffolk County is bordered by a long line of steep bluffs overlooking Long Island Sound. The line of bluffs is broken by several small embayments such as at Mount Sinai Harbor and Wading River (ERDA 1977).

Six principal stratigraphic units, some of which include subdivisions of minor importance, were recognized in the test drilling at BNL (ERDA 1977). Figure 3.5-2 presents a general cross-section of Long Island showing these strata and the direction of groundwater flow. At the base is the oldest unit, the bedrock of Pre-Cretaceous age, which has been given no formational name. Above the bedrock is the Raritan Formation of Cretaceous age, which is as much as approximately 150 m (500 ft) thick and has two members. The lower member, as much as approximately 90 m (300 ft) thick, is called the Lloyd Sand Member and is composed of coarse-grained sand, gravel, and some clay. The upper member, as much as approximately 60 m (200 ft) thick, is mostly clay and is called the Clay Member. Overlying the Raritan Formation is the Magothy Formation, also of Cretaceous age. Beneath BNL this formation consists of about 270 m (900 ft) of mostly clayey sand, and it includes beds of clay and of sand and gravel. Under most of the BNL tract, and in general under the southern half of central Suffolk County, the Magothy Formation is overlain by the Gardiners Clay of Pleistocene age. The sixth major stratigraphic unit is called the Upper Pleistocene Deposits, an informal term for the glacial deposits which, in nearly all Long Island, overlie the Gardiners clay or the Magothy formation. Most of these deposits consist of sand and gravel which, with local silt and clay, form the stratified outwash and morainal deposits of presumed Wisconsin age. Their maximum known thickness is about 60 m (200 ft). Most of the formations recognized here occur nearly everywhere beneath Long Island.

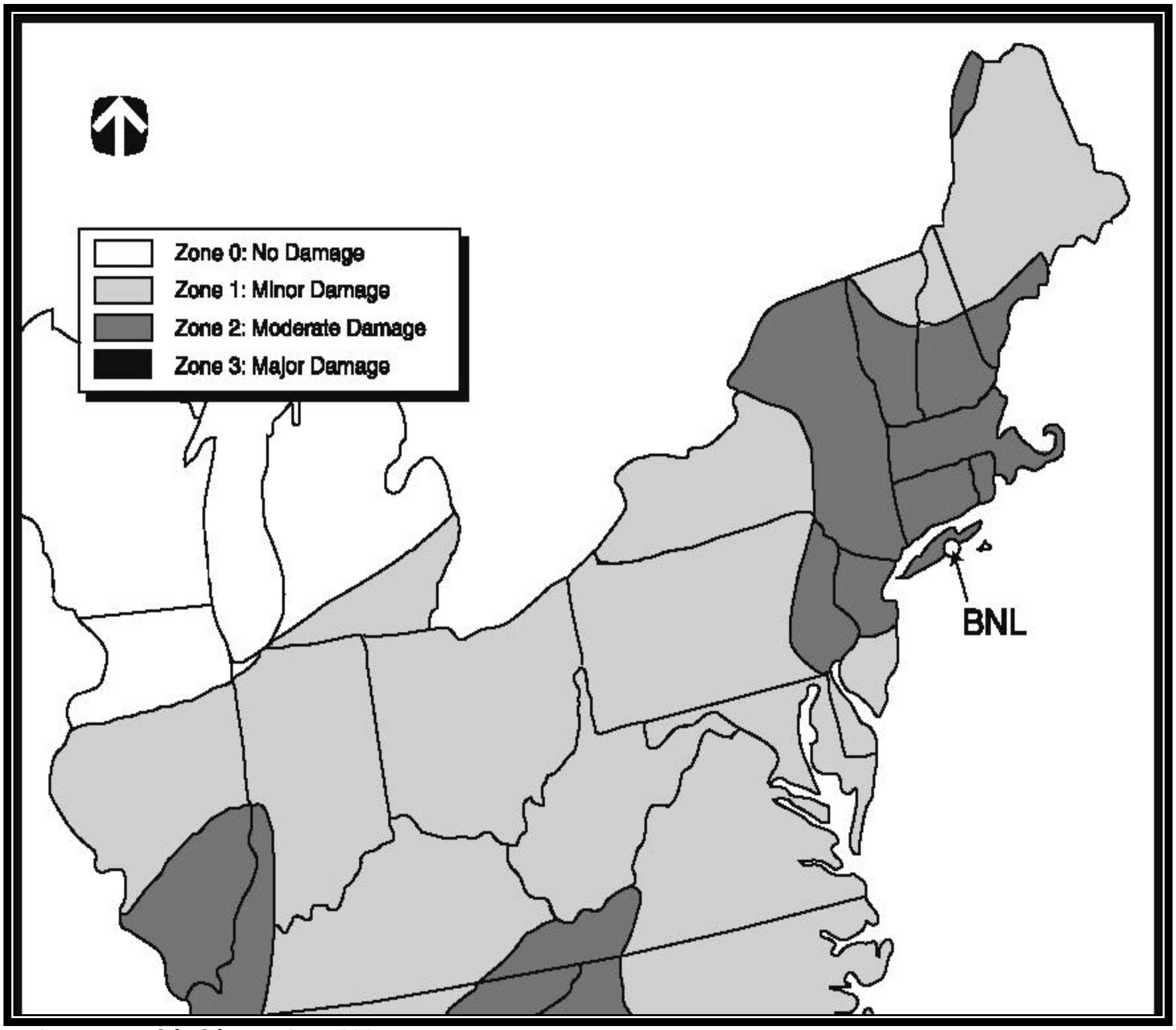
The shape of the upper surface of the hard, dense schist, gneiss, and granite bedrock of Long Island is best known beneath the west end. Here the bedrock surface, as indicated by well records, has a maximum relief of about 30 m (100 ft), except where is it near the surface and may have been modified by erosion in Pleistocene or recent times. The bedrock surface slopes southeast about 15 m/km (50 ft/mi) under most of Long Island, but seems to have a more southerly slope at the east end (see Figure 3.5-2).

The soils at BNL are predominately coarse, sandy soils derived largely from glacial outwash materials including the Ronkonkoma moraine. The soils in the area show distinct layering. Coarse gravel is often overlain by finer material. Surface deposits, which vary in texture, range from coarse Duke's sand in the north and east to finer Sassafras sandy loam in the southwest. The soil types on site, in order of increasing coarseness, are Sassafras loam, Sassafras fine sandy loam, Sassafras sandy loam, Plymouth sand loam, Duke's loamy sand, Plymouth sand, and Duke's sand. Babylon sand and meadows soil are associated with wet sites (ERDA 1977).

Long Island lies in a zone 2 ("moderate damage") seismic probability area (see Figure 3.6-1). It is assumed that an earthquake of intensity VII (Modified Mercalli) could occur (see Table 3.6-1). The reactor building and associated structures were initially designed to withstand horizontal acceleration of 0.1 g, which is in the range of intensity VII to VIII (Modified Mercalli) earthquakes. No active earthquake-producing faults are known in the Long Island area (ERDA 1977). The most recent recorded earthquake with observable effects occurred on October 19, 1985 at latitude 40.98° N longitude 73.83° W and had a magnitude of 4.0 on the Richter scale (see Table 3.6-1) with ground acceleration between 0.007 g to 0.015 g. This event was approximately 69 km (43 mi) west of BNL in White Plains, New York and had a Modified Mercalli Intensity of V (USGS 1998) which produced at least an order of magnitude less ground acceleration than the design standard for the reactor buildings and associated structures.

The probability of occurrence in the BNL area of an earthquake sufficiently intense to damage buildings and reactor structures was thoroughly investigated during the preparation of the *Final Safety Analysis Report* for the HFBR (BNL 1964). Additional analyses was performed in 1979 as part of a plan to increase reactor power to 60 MW. The facility was reviewed, using existing standards, against a "design basis earthquake (DBE) of 0.2 g. Although these analyses showed no damage to the reactor itself, it identified the operations level crane as a structure susceptible to failure during a DBE. The Probabilistic Risk Assessment (PRA) identified that the control room (which houses radiological monitoring and control systems) required reinforcement to withstand a DBE. At that time, some modifications were implemented to address safety concerns arising from the deficiencies discovered in the control room. Additional seismic upgrades required for the control room and operations level crane are discussed in Section 2.3.4 of this DEIS.

Figure 3.6-1 Seismic Zone Map of Northeastern United States.



Source: Modified from DOE, 1996.

Table 3.6-1. The Modified Mercalli Scale of 1931, with Approximate Correlations to Richter Scale and Maximum Ground Acceleration

Modified Mercalli Intensity[a]	**Observed Effects of Earthquake**	**Approximate Richter Magnitude**[b,c]	**Maximum Ground Acceleration**[d]
I	Usually not felt	2	negligible
II	Felt by persons at rest, on upper floors or favorably placed	2 to 3	<.003g
III	Felt indoors; hanging objects swing; vibration like passing of light truck occurs; might not be recognized as earthquake	3	0.003 to 0.007g
IV	Felt noticeably by persons indoors, especially in upper floors; vibration occurs like passing of heavy truck; jolting sensation; standing automobiles rock; windows, dishes, and doors rattle; wooden walls and frames may creak	4	0.007 to 0.015g
V	Felt by nearly everyone; sleepers awaken; liquids disturbed and may spill; some dishes break; small unstable objects are displaced or upset; doors swing; shutters and pictures move; pendulum clocks stop or start	5	0.015 to 0.03g
VI	Felt by all; many are frightened; persons walk unsteadily; windows and dishes break; objects fall off shelves and pictures fall off walls; furniture moves or overturns; weak masonry cracks; small bells ring; trees and bushes shake	6	0.03 to 0.09g
VII	Difficult to stand; noticed by car drivers; furniture breaks; damage moderate in well built ordinary structures; poor quality masonry cracks and breaks; chimneys break at roof line; loose bricks, stones, and tiles fall; waves appear on ponds and water is turbid with mud; small earthslides; large bells ring	6	0.07 to 0.22g
VIII	Automobile steering affected; some walls fall; twisting and falling of chimneys, stacks, and towers; frame houses shift if on unsecured foundations; damage slight in specially designed structures, considerable in ordinary substantial buildings; changes in flow of wells or springs; cracks appear in wet ground and steep slopes	7	0.15 to 0.3g
IX	General panic; masonry heavily damaged or destroyed; foundations damaged; serious damage to frame structures, dams and reservoirs; underground pipes break; conspicuous ground cracks	8	0.3 to 0.7g
X	Most masonry and frame structures destroyed; some well built wooden structures and bridges destroyed; serious damage to dams and dikes; large landslides; rails bent	8	0.45 to 1.5g
XI	Rails bent greatly; underground pipelines completely out of service	8	0.5 to 3g
XII	Damage nearly total; large rock masses displaced; objects thrown into air; lines of sight distorted	8+	0.5 to 7g

a. Intensity is a unitless expression to rank the severity of an earthquake by its effects on people and buildings.
b. Magnitude is an exponential function of seismic wave amplitude, related to the energy released.
c. Until the development of the Richter magnitude scale in 1935, the effects of an earthquake were measured by intensity scale.
d. Acceleration is expressed in relation to the earth's gravitational acceleration (g).
Source: DOE 1996.

3.7 ECOLOGICAL RESOURCES

3.7.1 BACKGROUND TO ECOLOGICAL RESOURCES

3.7.1.1 Definition of Resources

Ecological resources are defined as terrestrial and aquatic ecosystems characterized by the presence of native and naturalized flora and fauna. For the purposes of this EIS, ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Although wetlands and threatened and endangered species could be considered as either terrestrial or aquatic resources, they have been identified for separate analysis in this EIS because of their special regulatory status.

Terrestrial Resources: Terrestrial resources are defined as those species and communities that are most closely associated with the land. For the purposes of this EIS, terrestrial resources include the major ecological communities present and the organisms found within them.

Wetlands: Wetlands are defined by the U.S. Army Corps of Engineers (COE) and EPA as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Thus, wetlands are delineated based upon the occurrence of characteristic vegetation, soils, and hydrology.

Aquatic Resources: Aquatic resources are defined as those species and communities that are most closely associated with a water environment. For the purposes of the EIS, aquatic resources include the major habitats present and the organisms found within them.

Threatened and Endangered Species: Federally listed endangered species under the *Endangered Species Act* are defined as those native species in imminent danger of destruction or extinction in the United States, although the species may be demonstrably secure in other countries. Federally listed threatened species are those native species likely to become endangered within the foreseeable future. State endangered fish and wildlife species are defined as native species in imminent danger of destruction or extinction in New York or listed as endangered by U.S. Fish and Wildlife Service (USFWS). State threatened fish and wildlife species are native species likely to become endangered within the foreseeable future in New York (or listed as threatened by USFWS). Special concern fish and wildlife species are native species for which a welfare concern or risk of endangerment has been documented by the NYSDEC. Native plants (protected plants) in New York State are protected under a separate regulation, which categorizes plants as endangered, threatened, exploitably vulnerable, and rare species. NYSDEC, through its Natural Heritage Program, also identifies significant habitats. Significant habitats are areas which have unique ecological resources.

3.7.1.2 Approach to Defining the Environmental Setting

The primary source of information for this section is the 1995 *Phase II Sitewide Biological Inventory Report* (LMS 1995). This report presents the results of a comprehensive ecological inventory survey at BNL. The report establishes baseline information on the species and ecological communities at the site. Specific data sources used in that study include National Wetland Inventory (NWI) Maps, NYSDEC wetlands maps, aerial photographs, USFWS and NYSDEC Natural Heritage Program records on threatened and endangered species, and onsite field studies. Current Natural Heritage Program and USFWS records on endangered and threatened species were obtained in order to update the findings of the 1995 study (NYSDEC 1998; USFWS 1998). Ecological resources on the site and within 0.8 km (0.5 mi) of the property boundary were identified. For endangered and threatened species, the study area consisted of the site itself and all areas within 3.2 km (2 mi) of the site perimeter.

3.7.2 AFFECTED ENVIRONMENT

A total of 15 ecological communities have been identified on or within 0.8 km (0.5 mi) of the BNL property (LMS 1995). The communities were classified according to the dominant vegetation and the habitat each provides using the ecological classification system developed for New York State (Reschke 1990). A list of these communities, including their estimated areal extent and ranking, is provided in Table 3.7-1. Table 3.7-2 summarizes the dominant food-producing plants, birds, and mammals for each community. The dominant ecological community is shared by pine/oak forest and deciduous forest. For purposes of this EIS, the 15 ecological communities are divided into one of three categories: terrestrial, wetland, or aquatic. A description of each of these categories of resources at the site is provided below, followed by a discussion of endangered and threatened species. It should be noted that although a distinction is made between wetland and aquatic habitats for discussion purposes, both types of habitats may qualify as wetlands for regulatory purposes.

3.7.2.1 Terrestrial Resources

A total of seven terrestrial communities were identified in the study area. A description of each of these communities is provided below (LMS 1995).

Pine Plantations: Pine plantations, consisting of pine monocultures or mixtures of deciduous and coniferous species, are scattered throughout the site. The tree stands, composed of red pine (10 to 20 percent) and white pine (80 to 90 percent), are estimated to be approximately 60 years of age. Most of the trees are 12 m to 18 m (40 ft to 60 ft) tall and form a dense evergreen canopy, resulting in a sparse or absent shrub and ground cover layer. The scarce food supply offered by the pine plantation habitat limits wildlife use. Several large nests observed in the pines were probably used by American crows that were observed roosting in the plantations.

Moderately Mature Pitch Pine/Oak Forest: Located in the southern and northeastern portions of the BNL site, these forests consist chiefly of a coniferous open forest of pitch pine with scattered fire cherry, black locust, red pine, and oaks. The shrub layer is dominated by huckleberry and lowbush blueberry. Trees in the overstory are 7.5 m to 12 m (25 ft to 40 ft) in height, with diameters of 20 cm to 25 cm (8 in to 10 in) with no evidence of fire damage. The understory varies from sparse to very dense, depending on the density of the overhead tree canopy. This was the most common habitat on BNL and within the study area, based on estimated extent. The greatest number and diversity of wildlife species of any of the communities has been observed in the pitch pine/oak community. White-tailed deer, gray squirrel, cottontail, and chipmunk were common. Birds sighted included blue jay, downy and hairy woodpeckers, northern orioles, mourning dove, gray catbird, rufous-sided towhee, and warblers.

Predominantly Deciduous Forest: The predominantly deciduous forest community was the second largest ecological community identified on the site and within the study area. This community is evident where fire suppression activities have caused natural succession to progress to the point where pitch pine has declined and black locust, red maple, black oak, white oak, and fire cherry now dominate. Dominant trees are generally 6 m to 12 m (20 ft to 40 ft) in height and 15 cm to 20 cm (6 in to 8 in) in diameter, while the remaining pitch pines are 25 cm to 41 cm (10 in to 16 in) in diameter. The pines are generally in poor condition, with many dead or broken large branches; some are being overgrown by the faster-growing locust and oak. The ground cover consists of a sparse mixture of poverty grass, orchard grass, bracken fern, witchgrass, and fall panicum. Coralberry is a common shrub in the southern portion of the site, particularly along wooded roadsides. Several specimens of American chestnut were found in this

Table 3.7-1 Approximate Area of Ecological Communities on and Around the BNL Property[a]

Habitat Name	Habitat Reference No.[b]	Hectares	Area Ranking
Pine plantations	1	160	5
Moderately mature pitch pine-oak forest	2	1,500	1
Predominantly deciduous forest	3	1,360	2
Retention basins	4	5	13
Early successional shrub/sapling community	5	80	7
Palustrine forested wetlands	6	140	6
Lawn areas	7	180	4
Disturbed/developed areas	8	930	3
Cleared/lightly vegetated sand substrate	9	10	11
Pine barrens shrub/sapling wetlands	10	3	15
Coastal plain ponds	11	40	8
Herbaceous wetlands	12	12	10
Coastal plain stream	13	26	9
Sewage treatment ponds	14	4	14
Lacustrine wetlands	15	6	12

Note: Acreages are unsurveyed and approximate. They are based on review of aerial photographs, site observations, and descriptions provided by Reschke (1990).

[a] Ecological study area includes BNL property (approximately 2,150 ha or 5,300 acres) and communities within 3.2 km (2 mi) of the property boundary.

[b] Reference to habitat codes on Figure 3-3 of the *Sitewide Biological Inventory Report* (LMS 1995)

Source: LMS 1995.

Table 3.7-2. Ecological Communities, Food Supplies, and Consumers Associated With Each Habitat Observed at BNL

New York Ecological Community[a]	Habitat Reference No.[b]	Dominant Food-Producing Plants[c]	Dominant Birds (Insectivorous/ Herbivorous)[d]	Herbivorous Mammals[e]	Carnivorous or Insectivorous Mammals[e]
Pine plantations	1	Red pine (S) White pine (S)	Black-capped chickadee (R) Tufted titmouse (R) Red-breasted nuthatch (R)	White-tailed deer (0)	None observed
Moderately mature pitch pine/oak forest	2	Pitch pine (S) Fire cherry (B) Oaks (N)	Blue jay (R) Woodpeckers (R) Mourning dove (R) Gray catbird (M) Rufous-sided towhee (R)	White-tailed deer (0) Gray squirrel (0)	Fox (E)
Predominantly deciduous forest	3	Black locust (S) Oaks (N) Fire cherry (B) Huckleberry (B, BR) Deerberry (B, BR)	Cedar waxwing (R) Blue jay (R) Cardinal (R) Northern mockingbird (R)	White-tailed deer (0) Cottontail (0) Chipmunk (0) Gray squirrel (0)	Fox (E)
Retention basins	4	Reed canarygrass (S)	Barn swallow (M) Chipping sparrow (R) Red-winged blackbird (M)	White-tailed deer (0)	Raccoon (E) Moles (E)
Early successional shrub/sapling community	5	Multiflora rose (S) Hawthorn (B) Barberry(B) Fire cherry (B) Various grasses (BR)	Cardinal (R) Cedar waxwing (R) American robin (M/R) Northern mockingbird (R)	White-tailed deer (0) Cottontail (0)	Raccoon (E)

Table 3.7-2. Ecological Communities, Food Supplies, and Consumers Associated with Each Habitat Observed at BNL — Continued

Palustrine forested wetlands	6	Sedges, rushes, and grasses (S, R) Red maple (S) Blueberry (B, BR)	Woodpeckers (R) American robin (M/R) Northern junco (M) Black-capped chickadee (R)	White-tailed deer (0)	Fox (E) Raccoon (E)
Lawn areas	7	Various grasses (BR)	Common crow (R) Killdeer (M) European starling (R) Brown-headed cowbird (M) Northern mockingbird (R)	White-tailed deer (0) Cottontail (0) Woodchuck (0)	Moles (E)
Disturbed/developed areas	8	Various grasses (BR)	European starling (R) House sparrow (R) House finch (R) Mourning dove (R) Chimney swift (M) Barn swallow (M)	White-tailed deer (0)	None observed
Cleared/lightly vegetated sand substrate	9	Pitch pine (S)	Killdeer (M) Prairie warbler (M) Eastern bluebird (R/M)	None observed	None observed
Pine barrens shrub/sapling wetlands	10	Highbush blueberry (B) Winterberry(B)	Black-capped chickadee (R) Rufous-sided towhee (R)	White-tailed deer (0)	Raccoon (E)
Coastal plain ponds	11	Reed canarygrass (S) Duckweed (BR)	Eastern phoebe (M) Wood duck (M) Barn swallow (M)	White-tailed deer (0)	Raccoon (E)
Herbaceous wetlands	12	Reed canarygrass (S) Sedges (S, BR) Cattail (BR)	Black-capped chickadee (R) Red-breasted nuthatch (R)	White-tailed deer (0)	Raccoon (E)

Table 3.7-2. Ecological Communities, Food Supplies, and Consumers Associated with Each Habitat Observed at BNL — Continued

Coastal plain stream	13	Duckweed (BR) Pondweeds (BR) Waterweeds (BR) Naiads (BR)	American robin (M/R) Tufted titmouse (R) Northern junco (M) Common yellowthroat (M)	White-tailed deer (0)	Raccoon (E) Fox (E)
Sewage treatment ponds	14	None observed	None observed	None observed	None observed
Lacustrine wetlands	15	Coontail (BR) Pondweed (BR) Waterweed (BR)	Common yellowthroat (M) Tree swallow (M) Eastern phoebe (M)	White-tailed deer (0) Muskrat (E)	Raccoon (E)

NOTE: Of the bird species listed, all feed on plant parts (seed, berries) and insects when available. Woodpeckers, warblers, barn swallows, and chimney swifts feed chiefly on insects.
[a] Ecological communities based on Reschke (1990).
[b] Reference to habitat codes on Figure 3-3 of the Sitewide Biological Inventory Report (LMS 1995).
[c] Dominant food-producing plants: S - seeds; B - berries; N - nuts; BR - browse. Dominant food-producing plants are the basis of mammal and bird food chains.
[d] Dominant birds: R - resident; M - migrant
[e] Mammals: O-observed; E-evidence (tracks, droppings)
Source: LMS 1995.

community. A variety of birds use the deciduous forest as a resting and feeding area; bird species observed include cedar waxwing, blue jay, northern cardinal, American goldfinch, northern mockingbird, and gray catbird.

Early Successional Shrub/Sapling Community: This community is present along road edges, in overgrown access roads, and in other areas where vegetative succession has been taking place for 10 to 20 years. Trees, where present, average 1.5 m to 5 m (5 ft to 16 ft) in height and 7.5 cm to 15 cm (3 in to 6 in) in diameter. No defined canopy or understory has developed. Tree species include saplings of various types common to the site, such as black locust, pitch pine, and fire cherry. Smaller trees or shrubs include multiflora rose, hawthorn, and barberry. These shrubs provide a seasonal food supply for birds such as northern cardinal, cedar waxwing, American robin, and northern mockingbird.

Lawn Areas: The mowed recreation fields, lawns, and grassed roadsides on BNL are composed of a mix of grasses and herbaceous weeds that provide feeding areas for a number of wildlife species. Mammals observed included white-tailed deer, woodchuck, and eastern cottontail. Evidence of moles was visible as tunnels near the forested edges. The common crow, killdeer, European starling, brown-headed cowbird, northern mockingbird, and American robin were observed feeding on lawns.

Disturbed/Developed Areas: Located in the central and southern parts of the BNL complex, including the HFBR site, these areas include buildings, paved areas, fuel tanks, small patches of forest, lawn area, and plowed, planted fields. This was the third largest community identified within the BNL study area. Due to development, human activity, and broken, discontinuous habitat, the wildlife using this community consists chiefly of species tolerant of humans. Vegetative communities are represented by lawn, shrub/sapling community, patches of predominantly deciduous forest, and plantings of nonnative grasses/crops, shrubs, and trees. Planted trees consist of Norway spruce, Norway maple, and London planetree. European starling, house sparrow, house finch, mourning dove, chimney swift, and barn swallow were observed in the developed portions of the site.

Cleared/Lightly Vegetated Sand Substrate: This ecological community consists of recently cleared areas of sand that are either devoid of vegetation or in the early stages of plant succession and limited by a lack of organic matter and water-retention capacities. This habitat type is visible on the slopes of recharge basins, within the firebreaks, and in portions of the slopes and cuts associated with the particle accelerator ring. Scattered specimens of pitch pine, black locust seedlings, and small saplings grow here. Wildlife use of this area is limited because of the lack of food supply or cover. Birds observed in this habitat include the eastern bluebird, prairie warbler, northern bobwhite, and chipping sparrow.

3.7.2.2 Wetlands

A total of four wetland communities were identified in the study area. A description of each of these communities is provided below (LMS 1995).

Palustrine Forested Wetlands: Extensive forested wetlands mapped by NYSDEC and NWI are found in the northern and eastern areas of the site. These wetlands are identified by NWI as "PFO1C" (palustrine forested, broad-leaved deciduous, seasonally flooded) or "PFO1E" (palustrine forested, broad-leaved deciduous, seasonally flooded/saturated). Palustrine wetlands include all nontidal wetlands dominated by trees, shrubs, and persistent emergents. This was the largest of the wetland/aquatic communities identified in the study area. These areas have a canopy of red maple and gray birch, a shrub layer of swamp azalea and pepperbush, and a ground cover of moss, sedges, and rushes. Wildlife species observed included white-tailed deer, downy woodpecker, American robin, scarlet tanager, black-capped chickadee, and tufted titmouse.

Pine Barrens Shrub/Sapling Wetlands: Located on the northern portion of BNL and associated with the headwaters of the Peconic River, this wetland type is identified on the NWI maps as "PSS1E" (palustrine scrub/shrub, broad-leaved deciduous, seasonally flooded/saturated) or "PSS1C" (palustrine scrub/shrub, broad-leaved deciduous, seasonally flooded). These wetlands are usually found adjacent to either a coastal plain pond or a palustrine forested wetland. This was the least common ecological community observed within the study area. Shrub/sapling height in this wetland type is generally no more than 3 m to 5 m (10 ft to 16 ft). Characteristic plant species observed include leatherleaf, highbush blueberry, pepperbush, maleberry, fetterbush, buttonbush, winterberry, and greenbrier. As the shrub layer is extremely dense, this community provides excellent nesting habitat for small passerine birds (songbirds) such as the northern cardinal, northern mockingbird, blue jay, and various species of warblers.

Herbaceous Wetlands: These wetlands, present on the northern portion of BNL and associated with the headwaters of the Peconic River, are generally found where a prolonged period of inundation or saturation prevents growth of a forested or shrub community. This wetland type is identified on the NWI maps as "PEM1E" (palustrine emergent, persistent, seasonally flooded/saturated). Observed plant species include sedges, rushes, smartweed, swamp loosestrife, and common reed. The dense cover afforded by the common reed and cattail stands may provide nesting habitat for some bird species, such as the red-winged blackbird and field sparrow. Wildlife observed in herbaceous wetlands include raccoon (tracks), black-capped chickadee, red-breasted nuthatch, field sparrow, and white-throated sparrow.

Lacustrine Wetlands: This ecological community is found only in the open-water environment of Grassy Pond, northeast of BNL but within the 0.8 km (0.5 mi) study area. This community resembles the coastal plain pond described below, but is generally larger in area and deeper, featuring a diverse fish community. The lake is capable of supporting pan and game fish such as yellow perch, largemouth bass, and chain pickerel. NWI identifies Grassy Pond as "L1OWH" (lacustrine, limnetic [deepwater habitats], open water, permanently flooded). Lacustrine wetlands include permanently flooded lakes and reservoirs and intermittent lakes.

3.7.2.3 Aquatic Resources

A total of four aquatic communities were identified in the study area. A description of each of these communities is provided below (LMS 1995).

Retention Basins: Retention basins (or water recharge basins) are defined as constructed depressions near a road or development that receive stormwater or industrial runoff and allow water to percolate through (recharge) to the groundwater regime (Reschke 1990). These basins are intermittently flooded during spring runoff or periods of heavy precipitation. The water retention/recharge basin community was one of the least common communities identified in the BNL study area. Birds which may occur in this area include Canada goose, killdeer, wood duck, barn swallow, mallard, red-winged blackbird, chipping sparrow, field sparrow, and American goldfinch. Three of the BNL basins are listed by NWI as "POWKFx" (palustrine open water, artificially flooded, semi-permanently flooded, excavated) wetlands, including Recharge Basin HO. These designations were verified in the 1995 *Phase II Sitewide Environmental Inventory* (LMS 1995), and thus are subject to regulation by the COE.

Coastal Plain Ponds: The eleven ponds found in the northern portion of BNL and within the study area are naturally occurring ponds with permanent standing water (associated with the Peconic watershed) or man-made ponds within the particle accelerator ring. Virtually all of the ponds were less than 2 ha (5 acres) in size, circular in shape, without a defined inlet or outlet, shallow (0.6 m – 1.2 m [2 ft – 4 ft] deep), and with a dense substrate of organic ooze and fallen leaves. Seven of the coastal plain ponds are recognized as wetlands by NWI and mapped as "POWF" (palustrine open water, semipermanently flooded), "POWZ" (palustrine open water, intermittently exposed), or "POWH" (palustrine open water, permanently flooded). Aquatic vegetation commonly observed in these ponds includes coontail, duckweed, watershield, pondweeds, and white water lily. Waterfowl observed in the ponds includes Canada goose, wood duck, mallard, and greenwinged teal. Characteristic fish species for coastal plain ponds are chain pickerel and banded sunfish (Reschke 1990). Golden shiner, goldfish, mummichog, banded sunfish, pumpkinseeds, and brown bullhead were found in coastal plain ponds in the 1994 fish survey (LMS 1995).

Coastal Plain Streams: This ecological community is found throughout the north-south drainage of the Peconic River basin to Horn Pond (east of the site). NWI maps these coastal plain streams as "R20WH" (riverine, lower perennial, open water, permanent). These riverine wetlands are regulated concurrently by COE and NYSDEC. Coastal plain streams are low-gradient, low-velocity, slightly acidic waters with a moderate-to-dense growth of aquatic vegetation. Common aquatic plants include pondweeds, water-starwort, spiked bur-reed, duckweed, and bladderwort. The dense aquatic growth provides cover for fish and invertebrates and forage for mammals such as muskrat and white-tailed deer. Most of the stream channel is moderately to heavily shaded by a tree canopy of red maple and black gum. Streamflows are heavily influenced by groundwater level, with infiltration into the streambed from groundwater during periods of high rainfall and absorption of streamflow into the streambed during periods of low rainfall. Characteristic fishes expected in this habitat include American eel, redfin pickerel, eastern banded killifish, pumpkinseed, banded sunfish, and swamp darter (Reschke 1990). Painted turtles, snapping turtles, a stinkpot, and green frogs were observed in the stream during the site surveys.

Sewage Treatment Ponds: Reschke (1990) describes this ecological community as "the aquatic community of an artificial pond constructed for sewage treatment (chemical and biological decomposition of sewage) prior to its release to a stream or aquifer" or in this case, the aeration and settlement ponds that release effluent from the BNL filtration plant to the Peconic River. This was one of the least common communities identified in the BNL study area. Composition of the sewage, water quality, water level, and temperature probably limits use of the habitat by any wildlife species, and periodic cleaning of the basins precludes establishment of an aquatic or emergent plant community. However, painted turtles and bullfrogs were observed in the sand filter beds of the sewage treatment plant during the summer of 1994. Rough-winged swallows, tree swallows, and chimney swifts were also observed feeding on insects over the two ponds. Killdeer and solitary sandpipers were also observed feeding in the sand filter beds within the sewage treatment facility. The wildlife value of the ponds onsite is somewhat diminished by fencing and the large, cleared area peripheral to the treatment lagoons.

3.7.2.4 Threatened and Endangered Species

State and Federally listed threatened, endangered, or special concern wildlife species reported to occur in the study area are listed in Table 3.7-3. This table shows the species name, New York State status, Federal status, and the source from which the information is taken. Various State and Federally protected wildlife species were observed on BNL in 1994, including eastern tiger salamander (State endangered), osprey (State threatened), and common nighthawk, eastern bluebird, spotted turtle, spotted salamander, banded sunfish, and eastern hognose snake (special concern species). Onsite breeding areas were confirmed for the tiger salamander during a species-specific study (LMS 1995).

Five plant species and eight fern species found on BNL are classified as protected plants under New York State law. The plant species found were the butterflyweed, spotted wintergreen, lady's slipper, bayberry, and flowering dogwood. The eight species of protected ferns found were hayscented fern, shield fern, sensitive fern, cinnamon fern, Clayton's fern, royal fern, marsh fern, and Virginia chain fern (LMS 1995). In addition, one protected plant species, drowned horned rush, is reported by the Natural Heritage Program to occur in the site vicinity but has not been identified onsite (NYSDEC 1998).

Two NYSDEC-mapped significant habitat sites are located on BNL (NYSDEC 1998). The following is a brief description of each area and the rationale for its designation as a significant habitat site.

Water Tank Pond: (NYSDEC No. SW 52-578). This pond, located in the southeast corner of BNL just north of the LIE, is mapped by NYSDEC as a Class I wetland. Class I wetlands are the most valuable of the four classification levels of wetlands established by NYSDEC. Water levels in this pond are variable throughout the year. For example, as reported in the 1995 LMS study, the pond held water from at least December 1993 to mid-June 1994, but was dry from August through December 1994. When full, the pond is approximately 1 m (3 ft) deep (LMS 1995).

Peconic River and Drainage: (NYSDEC No. SW 52-562). This site, located in the northern portion of BNL, includes all the tributaries, ponds, and wetlands associated with the Peconic from its headwaters west of the BNL property, eastward to Riverhead. The Peconic is recognized as a significant fish and wildlife habitat along an approximately 24 km (15 mi) long freshwater reach from County Route 63 in the center of Riverhead west to its headwaters in Peconic River County Park (LMS 1995).

Table 3.7-3. State and Federally Listed Threatened, Endangered, or Special Concern Wildlife Species Reported to Occur in the Study Area

Common Name	Scientific Name	NYS Status	Federal Status	Reference: 1995 Biological Inventory Report (LMS 1995)	Reference: NYSDEC Natural Heritage Program (NYSDEC 1998)
Common loon	*Gavia immer*	SC	-	√	
Red-shouldered hawk	*Buteo lineatus*	T	-	√	
Cooper's hawk	*Accipiter cooperii*	SC	-	√	
Golden eagle	*Aquila chrysaetos*	*	-	√	
Bald eagle	*Haliaeetus leucocephalus*	E	T	√	
Northern harrier	*Circus cyaneus*	T	-	√	
Osprey	*Pandion haliaetus*	T	-	√	
Common tern	*Sterna hirundo*	T	-	√	
Common nighthawk	*Chordeiles minor*	SC	-	√	
Eastern bluebird	*Sialia sialis*	SC	-	√	
Loggerhead shrike	*Lanius ludovicianus*	E	-	√	
Grasshopper sparrow	*Ammondramus savannarum*	SC	-	√	
Vesper sparrow	*Pooecetes gramineus*	SC	-	√	
Spotted turtle	*Clemmys guttata*	SC	-	√	
Eastern hognose snake	*Heterodon platirhinos*	SC	-	√	
Eastern worm snake	*Carphophis amoenus*	SC	-	√	
Spotted salamander	*Ambystoma maculatum*	SC	-	√	
Eastern tiger salamander	*Ambystoma tigrinum*	E	-	√	√
Banded sunfish	*Enneacanthus obesus*	SC	-	√	

E - endangered
T - threatened
SC - special concern
* - presently extinct in New York State
- not listed
√ - reported to be present

3.8 CULTURAL RESOURCES

3.8.1 BACKGROUND TO CULTURAL RESOURCES

Cultural resources are defined and protected by a series of Federal laws, regulations, and guidelines. For this EIS, cultural resources include prehistoric, historic, and Native American resources. Paleontological resources are also addressed.

3.8.1.1 Definition of Resources

Prehistoric Resources. Prehistoric resources are physical remains from human activities that predate written records. These resources generally are identified as artifacts, sites, or districts. Isolated artifacts may include stone or bone tools, or remains of ceramic pottery. Sites may contain concentrations of artifacts (for example, stone tools and broken pieces of ceramic vessels), features (such as remains of campfires, residences, or food storage pits), and human, plant, and animal remains. All of these resources can be used to reconstruct life in a region or at a limited location. Depending on their age, complexity, integrity, and relationship to one another, sites may be important for, and capable of, yielding otherwise inaccessible information about past populations.

Historic Resources. Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are generally considered to be those that date no earlier than 1492. Historic resources include architectural structures or districts (for example, religious, commercial, or residential structures, dams, and bridges), archaeological objects, and archaeological features (for example, foundations of mills or residences, trails, and trash dumps). Ordinarily, sites less than 50 years old are not considered historic for analytical purposes, but exceptions can be made for younger properties if they are of exceptional importance, such as structures associated with Cold War themes (36 CFR 60.4).

Native American Resources. Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. In addition, cultural values are placed on natural resources such as plants, which have multiple purposes within various Native American groups. Of primary concern are concepts of sacred space that create the potential for land-use conflicts. Native American resources can include geological or geographic elements such as mountains or creeks, certain species of plants and animals, cemeteries, battlefields, trails, structural remains, and archaeological sites.

Paleontological Resources. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. They include casts, molds, and trace fossils such as burrows or tracks. Fossil localities include surface outcrops and environments that assist preservation (for example, caves, peat bogs, or tar pits). These resources are important because they provide scientific information on paleoenvironments and the evolutionary history of plants and animals.

3.8.1.2 Approach to Defining the Environmental Setting

Data used to assess the potentially affected cultural or paleontological resources include information regarding the historic and prehistoric context of the proposed HFBR project area, its geology and paleontological potential, and the possible presence of sites, districts, or objects that may be eligible for listing on the National Register of Historic Places (NRHP) or may be significant to Native American groups.

The methodology for identifying, evaluating, and mitigating impacts to cultural, historical, and Native American resources has been established through Federal laws and regulations, including the *National Historic Preservation Act* as amended (NHPA 1966), the *Archaeological Resources Protection Act* (ARPA 1979), the *Native American Graves Protection and Repatriation Act* (NAGPRA 1990), and the *American Indian Religious*

Freedom Act (AIRFA 1978). A project affects a significant resource when it alters a property's characteristics, including relevant features of its environment or use(s) that qualify it as significant according to criteria used for the NRHP. Impacts to cultural resources of value to Native Americans, such as sacred areas or hunting and gathering areas, should be determined through consultation with the affected Native American groups. Consultation is also required for assessing impacts to archaeological sites with human remains.

3.8.2 AFFECTED ENVIRONMENT

The area surrounding BNL was originally inhabited by two Native American tribes, the Seatalcotts and the Unkechaugs. Today there are two Long Island tribes recognized by the State of New York that maintain reservations dating to the 18th Century, the Shinnecocks in Southampton and the Poosepatucks in Mastic. The Montaukett Indians from the South Fork area are not formally recognized by the State of New York, but are asking for formal recognition from the Federal government. At this time none of the Native American groups on Long Island have received Federal recognition (Wick 1998).

The town of Brookhaven was settled in 1655. Whaling and milling were major industries on Long Island during the 1600s and early 1700s. During the Revolutionary War, several skirmishes occurred at the site now known as Brookhaven; the most famous of these was the raid on the Manor of St. George, an English fort. A rebel force captured the fort, destroyed English sailing vessels, and returned with 54 prisoners, all without the loss of an American life. Throughout the 19th Century, Port Jefferson was a major shipbuilding center. The area also supported oystering, brick-making (using the mid-island clay beds), and truck farming (Newsday 1998). With the dawn of the 20th century the area directly joined the World War I effort when the Army built Camp Upton in the center of Suffolk County. The camp was utilized as an induction center through World War II, was declared surplus in 1945, and in 1946 was transferred to the Atomic Energy Commission in order to establish BNL. BNL was established in January 1947 (ERDA 1977).

BNL was built on the former site of Camp Upton, an Army camp named to honor Civil War hero Brigadier General Emery Upton. The camp was operated between 1917 and 1920 during World War I, and again between 1940 and 1945 during World War II (BNL 1995a).

In 1917 construction of a U-shaped encampment large enough to house 40,000 troops was begun. The area was cleared of vegetation and a rail spur was constructed connecting Upton to the Long Island Railroad. When the camp was completed it became the Nation's 51st largest city and doubled the population of Suffolk County. After World War I, the camp briefly served as a demobilization site for returning veterans (BNL 1995a).

In 1921 a public auction was held and equipment and buildings were sold and removed. Between the wars, the site was not abandoned but remained unused and was known as Upton National Forest (BNL 1995a).

In 1940 the camp was rebuilt for use during World War II as the 1,222nd Induction Center. When the war effort moved into the Pacific, the induction center moved to Fort Dix, New Jersey and the camp became a convalescent and rehabilitation hospital in September 1944. Camp Upton was officially declared surplus, but not dismantled, on June 30, 1945 (BNL 1995a).

In January 1947, BNL was created within Camp Upton's previous boundaries. BNL was established as a multidisciplinary scientific research center when nine universities joined together under the name Associated Universities, Inc. As one of three national research laboratories for the peaceful uses of atomic energy, including nuclear reactors and particle accelerators, BNL is known as an institution of basic and applied scientific research in a multitude of disciplines, as well as a builder of world-class scientific machines (BNL 1995a, DOE 1994).

3.8.2.1 Cultural Resources

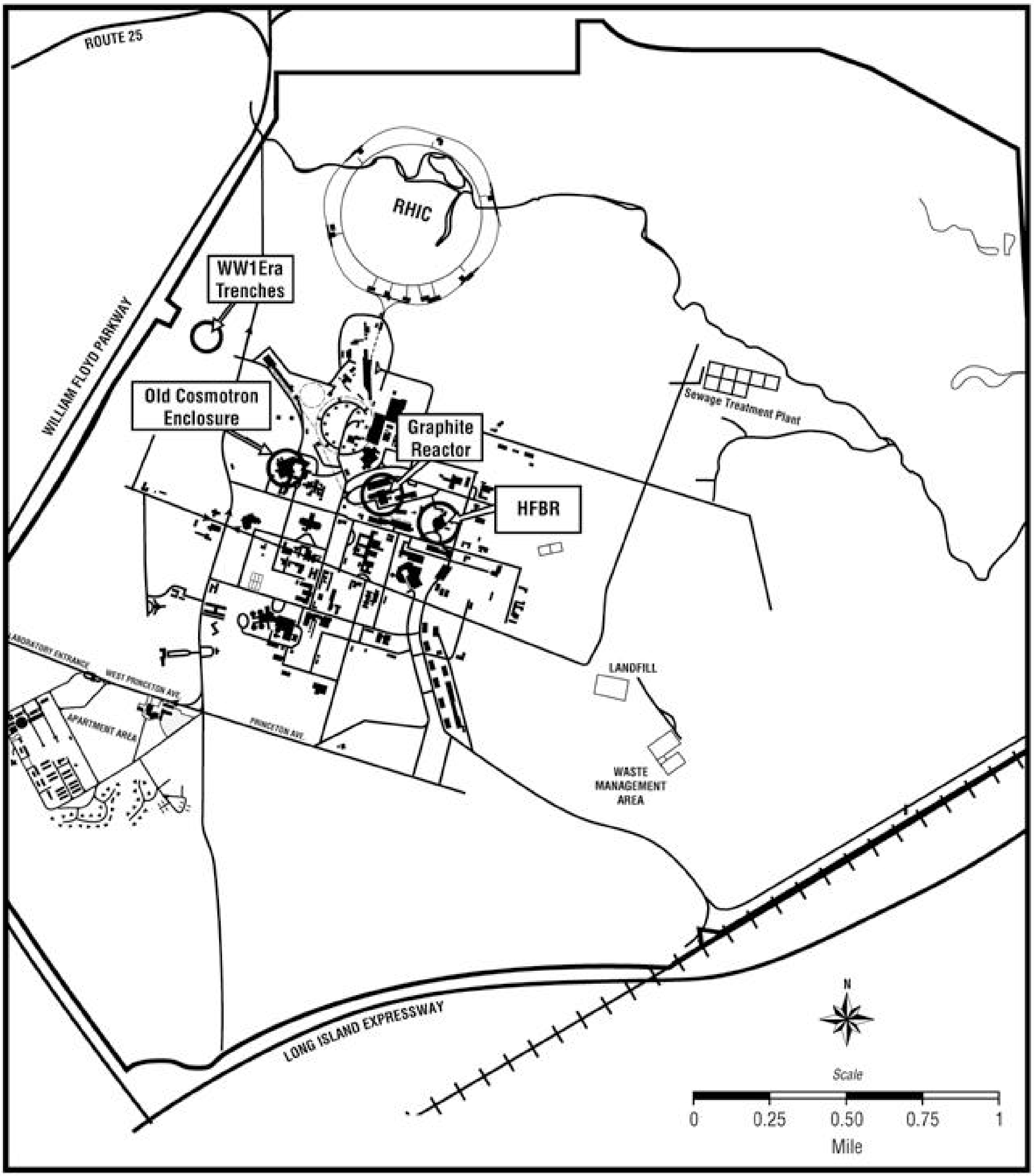
When research was being performed for the most recent site-wide BNL EIS, the preparers contacted the New York State Department of Parks and Recreation regarding cultural resources at BNL. In response to that inquiry, a letter dated September 16, 1974 was issued stating that there were no records of archaeological sites for the area occupied by BNL. The letter further suggested that areas of potential archaeological interest at BNL be surveyed by a qualified archaeologist. BNL complied with that request, and the survey was preformed by an archaeologist from the Long Island Chapter of the New York State Archaeological Association. The archaeologist's report was incorporated into the 1977 BNL EIS. Included in the survey was a search of Suffolk Counties cultural resource records and reports from 1916 through 1974. Two areas had been previously examined in the vicinity of BNL: a late Woodland occupation site approximately 2,750 m (9,000 ft) north of the BNL boundary, and Lake Panamoka approximately 600 m (2,000 ft) north of Tarkill Pond. Five additional areas were examined by hand-auger test borings for the BNL project: Zeeks Pond, the Peconic River, a wooded area north and parallel to Fifth Ave., a small pond and nearby marsh area, and Half Moon Pond. The report concluded that while flora, fauna, and water resources on BNL are similar to other areas of Native American occupation or use, no cultural resources were identified at BNL (ERDA 1977).

The Deputy Commissioner for Historic Preservation of the New York State Office of Parks, Recreation, and Historic Preservation issued a determination on April 2, 1991 that only three areas of the site were considered eligible for preservation activities: the Graphite Reactor Building (Building 701), the Old Cyclotron Enclosure (Building 902), and a small area of World War I era trenches (approximately 30 m by 30 m [100 ft by 100 ft]) (Figure 3.8-1). None of these three culturally significant areas are near the HFBR. No other areas at BNL are eligible for inclusion in the NRHP (DOE 1994, BNL 1995a, BNL 1996b).

3.8.2.2 Paleontological Resources

BNL has been constructed above unconsolidated sediments (sand, gravel and clay) and older Cretaceous sediments that lie on top of nearly impermeable crystalline bedrock. The hydrology and geology in this area indicate that the uppermost Pleistocene deposits, the Upper Glacial Aquifer, have a thickness of approximately 30 m to 60 m (100 ft to 200 ft) and are primarily composed of highly permeable glacial sands and gravels (BNL 1998e, BNL 1996b). To date, no paleontological remains have been discovered at BNL.

Figure 3.8-1. Historically Significant Sites at BNL.



3.9 SOCIOECONOMICS

3.9.1 DEFINITION OF RESOURCE

Socioeconomics comprise the social, economic, and demographic characteristics of an area. The socioeconomic environment can be affected by changes in employment, income, and population, which in turn can affect other resources such as housing and community services. Health care, education, and public safety are assessed as indicators of effects on community services.

3.9.2 DEFINING ENVIRONMENTAL SETTING

Possible economic and demographic effects are assessed at the ROI level. For purposes of this EIS, the ROI has been defined as Suffolk and Nassau Counties, which also forms a Metropolitan Statistical Area. This ROI includes the area where the majority of BNL employees reside.

Potential demographic, housing, and community service effects are also assessed for the ROI. Changes in BNL employment levels and spending would have the largest effect on these resources located within the area in which employees reside, commute to and from work, and use public services. The most recent data available are used for the socioeconomic analyses. Data were obtained from sources such as the U.S. Bureau of Census, the Bureau of Economic Analysis (BEA), the Bureau of Labor Statistics (BLS), the U.S. Department of Justice, the American Medical Association (AMA), the American Hospital Association (AHA), and State and local governments.

3.9.3 AFFECTED ENVIRONMENT

This section presents an overview of current socioeconomic conditions within the ROI. Although the ROI is well developed, it contains no major cities. Some of the larger cities in the ROI are Hempstead, Freeport, Valley Stream, Long Beach, and Glen Cove in Nassau County, and Lindenhurst, Islip, and Smithtown in Suffolk County.

BNL exerts an important influence on the regional economy. During Fiscal Year 1998, BNL employed approximately 3,100 permanent workers (BNL 1998j). In addition, BNL hosts an additional 3,200 temporary workers, primarily visiting scientists (BNL 1995a). BNL's permanent workforce population is projected to remain stable through the year 2000. BNL's impact on the local economy is amplified by the large proportion of high wage jobs generated by the facility. Almost 50 percent of the staff are classified as scientific, engineering, or other professional, and another 25 percent are managers or technicians. BNL has a budget of $400 million, and through secondary effects of BNL spending, the total effect of BNL on the Long Island economy is estimated at approximately $1 billion (BNL 1995a).

3.9.3.1 Employment and Income

The BNL ROI is suburban in character, although numerous local governments have in recent years purchased farm and park lands to preserve the rural aspects of the region. The western portion of the ROI is more developed and contains a higher density of commercial and manufacturing establishments than the eastern sections of the ROI. Almost all of the region's small agricultural output is produced in Suffolk County.

Over the past decade, the regional economy has become more diversified and less dependent on defense-oriented manufacturing. Growth industries in the ROI include high-tech electronics, software development, biotechnology, biomedical instrumentation and support services, and health care information systems. The service sector is the single largest source of jobs in the ROI, providing almost 35 percent of the total employment in the region. Retail and wholesale sales, government, finance, insurance, and real estate and manufacturing are also significant contributors to ROI employment. Together, these sectors provide almost 90 percent of the total employment in the

Table 3.9–1. ROI Employment by Sector

Sector	1990 Percentage	1995 Percentage
Services	31.2	34.9
Wholesale and Retail	22.6	22.9
Government	13.7	13.0
Manufacturing	11.0	8.6
Finance, Insurance, Real Estate	11.0	10.5
Construction	5.2	4.6
Transportation	4.1	4.3
Agricultural Service, Forestry, Other	0.9	1.1
Farming	0.2	0.2
Mining	0.1	0.1

Source: BEA 1997.

region (BEA 1997). As seen in Table 3.9–1, the service, wholesale and retail trade, and transportation sectors have increased in importance during the 1990s, while the percentages of regional jobs in the government, manufacturing, finance, and construction sectors have decreased.

The early 1990s were characterized by slow regional growth. In fact, the ROI labor force decreased in size from 1,416,713 in 1990 to 1,365,462 in 1996, a loss of 3.6 percent. Total ROI employment also decreased, falling from 1,360,157 in 1990 to 1,301,995 in 1996 (BLS 1997). Labor force projections show an increase in the labor force over the next decade, however, with the labor force increasing from 1,463,000 in the year 2000 to 1,536,600 in 2005. Slow but stable growth is projected through the year 2010 (NYMTC 1996).

The ROI unemployment rate was 4.2 percent in 1996, the lowest level since 1990. The unemployment rate was 4.7 percent in Suffolk County compared to 3.8 percent in Nassau County. Average unemployment in New York State was 6.2 percent during 1996 (BLS 1997). Per capita income for the region was $32,108 in 1995, a 16 percent increase over the 1990 level of $27,654. The 1995 per capita income for Nassau County was $36,894, over 14 percent higher than the $32,108 per capita income for Suffolk County. These income levels were much higher than the $27,572 per capita income level for New York State (BEA 1997).

3.9.3.2 Population

From 1970 to 1995, ROI population grew very slowly. From 1970 to 1980 the ROI increased from approximately 2,553,100 to 2,605,800, an increase of only 2.1 percent or an annual growth rate of 0.2 percent. During the 1980s, population growth slowed further, increasing only 0.1 percent over the entire decade, and remained slow through the beginning of the 1990s. The population growth rate has accelerated over the past few years and is projected to increase at an annual rate of 0.3 percent through the year 2000, and 0.5 percent between 2000 and 2005. The two counties comprising the ROI, however, have experienced very different growth patterns over the last 25 years. During the period 1970-1995, Nassau County population decreased by 8.8 percent, while Suffolk County population increased by 19.7 percent. Table 3.9–2 presents population estimates for the region through 1995, and projections for 2000 and 2005. The largest cities in the region are Hempstead and Freeport, both of which are in Nassau County, with 1996 populations of approximately 46,600 and 40,160, respectively. The largest city in Suffolk County is Lindenhurst, with a population of 26,879 (Census 1997).

Table 3.9–2. Population Estimates for BNL Region of Influence

County	1970	1980	1990	1995	2000	2005
Nassau	1,428,100	1,321.600	1,287,300	1,302,300	1,318,800	1,329,600
Suffolk	1,125,000	1,284,200	1,321,900	1,347,300	1,367,300	1,423,300
ROI	2,553,100	2,605,800	2,609,200	2,649,600	2,686,100	2,752,900

Source: NYMTC 1996.

3.9.3.3 Housing

There were a total of 927,609 housing units in the ROI in 1990. Approximately 79 percent of the units were single-family units, 19 percent were multi-family units, and 2 percent were mobile homes. Approximately 8 percent of the housing units were vacant, although over half of the vacant units were used for seasonal, recreational, or other occasional purposes. Rental vacancy rates were 4.1 percent in Nassau County and 7 percent in Suffolk County. About 80 percent of the occupied housing units in the region were homeowner units and 20 percent were rental units (Census 1992).

The median value of the owner-occupied housing units was $165,900 in Suffolk County and $209,500 in Nassau County, while the median monthly contract rent was $696 in Suffolk County and $678 in Nassau County (Census 1992). Table 3.9–3 shows selected housing characteristics for the ROI.

3.9.3.4 Community Services

This assessment evaluates the following selected community services in the ROI: public schools, law enforcement, fire protection, and medical services.

Public Schools: The ROI contains a total of 128 school districts. Suffolk County's 71 school districts had an enrollment of 223,905 students during the 1995-1996 school year. Approximately 180,270 students were enrolled in the 57 school districts located in Nassau County. The student-teacher ratio was about 13.0:1 in Nassau County and 14.4:1 in Suffolk County (LIBN 1997).

Law Enforcement: Law enforcement in the ROI is provided by 31 police departments that employed 6,774 sworn officers and 2,002 civilians in 1995. Nassau County and the Suffolk Police Department are the two largest law enforcement agencies in the area, and together employ 85 percent of the police officers in the ROI. The other police departments in the ROI are operated by municipalities and range in size from one employee (one officer) in Greenport Town, Suffolk County to 122 employees (95 officers) in Hempstead Village, Nassau County (DOJ 1996).

BNL maintains its own security force to provide site-wide protection against theft, sabotage, vandalism, and terrorism. The force, which numbers over 50 employees, are highly trained and are on duty at all times. The protective force is also trained to respond to and provide assistance during National disasters such as fires, floods, and radiological and toxicological accidents.

Table 3.9–3. Housing Characteristics (1990)

County	Total Housing Units	Number of Homeowner Occupied Units	Homeowner Vacancy Rates	Median Value	Number of Renter Occupied Units	Renter Vacancy Rates	Median Monthly Contract Rent
Nassau	446,292	431,515	1.2	$209,500	84,372	4.1	$678
Suffolk	481,317	424,719	1.9	$165,900	84,466	7.0	$696
ROI	927,609	856,234	NA	NA	168,838	NA	NA

NA= Not Applicable
Source: Census 1992.

Fire Protection: Suffolk County is served by 110 volunteer fire departments and 30 volunteer ambulance corps, which answered 132,024 emergency calls in 1996 (SC 1997). The Suffolk County Department of Fire, Rescue and Emergency Services operates a county-wide fire rescue dispatch center, which is staffed by 31 emergency services dispatchers, six shift supervisors, and one chief of communications. Nassau County has 71 fire districts with fire-fighting capacity and emergency response services. In addition, BNL has its own Fire/Rescue group that provides fire-fighting and emergency medical services to the facility and its onsite personnel. The BNL Fire/Rescue Group is a full-time paid department staffed with five firefighters and one officer per shift (BNL 1997d). The BNL Fire/Rescue Group owns two pump trucks and one rescue vehicle. Finally, Suffolk County, which surrounds BNL, has developed emergency plans to be implemented in the event of a hazardous materials emergency. Each emergency plan identifies facilities with extremely hazardous substances and defines transportation routes for these substances. The emergency plans also include procedures for notification and response, listings of emergency equipment and facilities, evacuation routes, and training programs.

Medical Services: The ROI contains 27 hospitals with a capacity of 11,457 beds (AHA 1996). About 56 percent of the hospital beds are in Nassau County and 44 percent in Suffolk County. The Nassau County Medical Center with 1,384 beds, and the North Shore University Hospital, also in Nassau County with 958 beds, are the two largest hospitals in the ROI. The largest medical facility in Suffolk County is a Veterans Hospital. The Good Samaritan Hospital Center with a total of 525 beds is the largest general admission hospital in Suffolk County. During 1995, these hospitals had a bed occupancy rate of approximately 80 percent.

BNL also has an onsite occupational medicine clinic, which provides routine employee health services. For emergencies, BNL relies on Emergency Medical Technicians associated with the Fire and Rescue Department. Patients are transported to one of several local hospitals. In addition, BNL has access to the Suffolk County Police MEDIVAC helicopter, which automatically goes to the University Hospital.

3.10 TRANSPORTATION

3.10.1 BACKGROUND TO TRANSPORTATION

3.10.1.1 Definition of Resources And Approach

The transportation assessment focuses on two issues: traffic and the transportation of spent fuel elements. The traffic assessment focuses on the number of vehicles associated with each alternative entering and leaving BNL. Transportation of spent fuel focuses on the risks of shipping spent fuel elements from BNL offsite to an appropriate facility.

3.10.2 AFFECTED ENVIRONMENT

3.10.2.1 Traffic

Traffic associated with each alternative, on a regional basis, focuses on two major roadways: the LIE and the William Floyd Parkway. The LIE runs east-west through the center of Long Island connecting Riverhead to New York City. BNL is located just north of Exit 68 on the LIE. Along the LIE, BNL is approximately 100 km (60 mi) from New York City and 23 km (14 mi) from Riverhead. The William Floyd Parkway traverses north-south across Long Island connecting Wading River to Smith Point County Park at the Fire Island National Seashore. BNL is located approximately 6 km (4 mi) south of Wading River and 16 km (10 mi) north of Smith Point County Park, along the east side of the William Floyd Parkway.

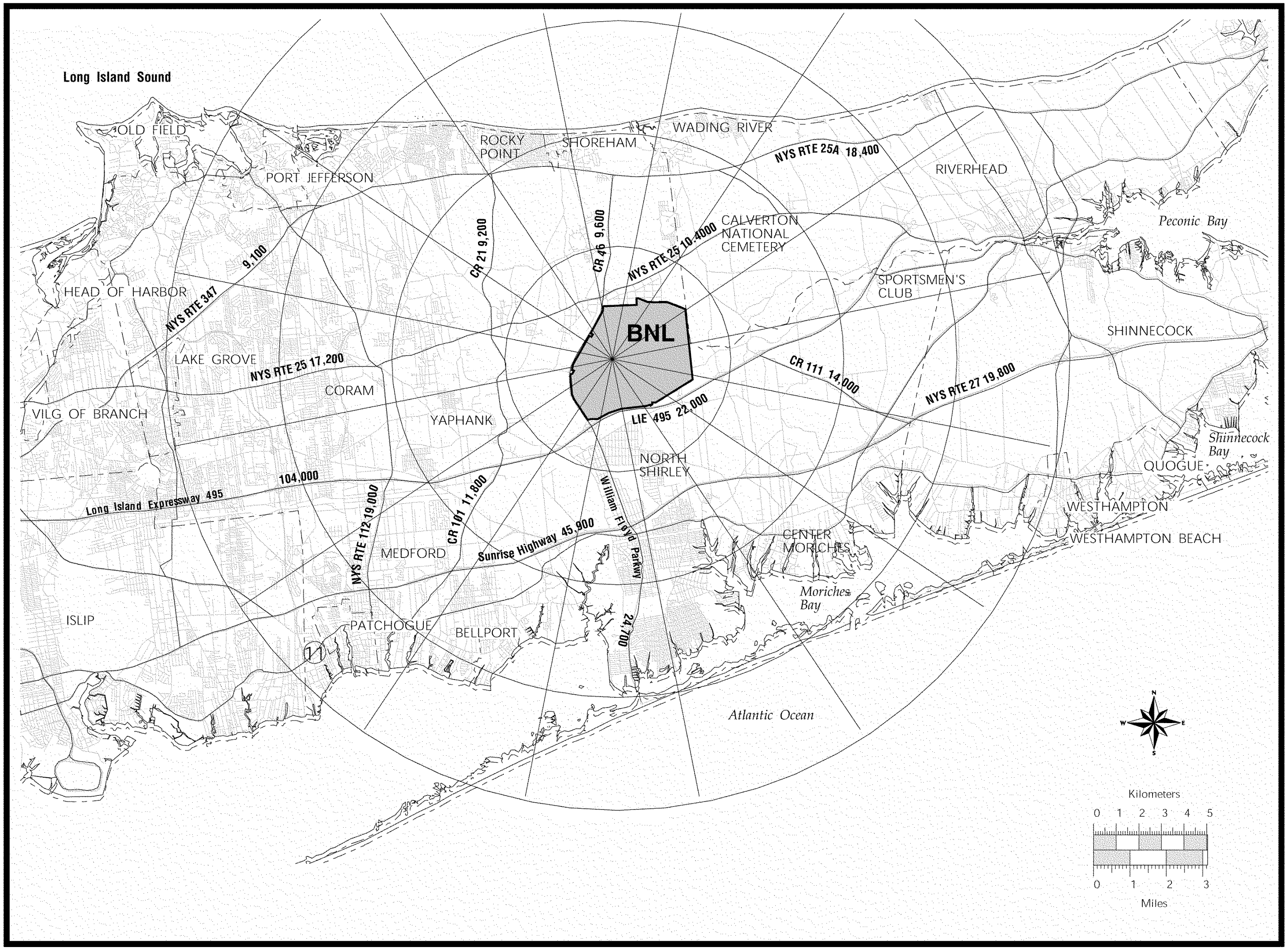
In 1996, the Town of Brookhaven prepared the *1996 (100 Day) Land Use Plan* that included traffic data (SECE 1996). Traffic data supplied by the Town of Brookhaven over a 100-day period (as shown on Figure 3.10-1 and tabulated in Table 3.10-1) demonstrated that the average daily traffic volume (two ways) is 61,500 vehicles at Exit 68 on the LIE. The average daily traffic volume (two ways) on the William Floyd Parkway north of Exit 68 was 22,500 vehicles. Continuing north on the William Floyd Parkway, between Route 25 and 25A, average daily two-way traffic volume is reported to be about 9,600 vehicles. For comparative purposes, the Town of Brookhaven *1996 (100 Day) Land Use Transportation Plan* reports that County Road 83 (North Ocean Avenue) north of the LIE handles average daily two-way traffic of approximately 46,200 vehicles, New York State Route 112 has approximately 22,500 vehicles daily, and Route 25 between Miller Place-Coram Road and Wading River Road had approximately 30,600 vehicles travelling on it daily (SECE 1996).

The main entrance of BNL is located on the east side of the William Floyd Parkway approximately 3 km (2 mi) north from Exit 68 of the LIE. The HFBR supports personnel from several BNL Divisions including medical, biology, chemistry, physics, and facilities engineering. Approximately 130 BNL personnel are involved in working at the HFBR (Ports 1998b). Although the HFBR is not currently operational, these personnel are, for the most part, still employed at BNL. Therefore, a maximum of 130 vehicles would be traveling to and from BNL as a result of the HFBR. This number in all likelihood overestimates traffic to and from BNL because it does not account for car pooling or the fact that there is onsite housing.

3.10.2.2 Transportation of Spent Fuel

Currently, there are no HFBR spent fuel elements onsite at BNL. Historically, spent fuel elements were stored in the spent fuel pool, sometimes for several years, before being shipped offsite. At the request of the City of New York, a report was prepared which focused on alternative routes for shipment of spent fuel elements (ADL 1984). The report identified and compared various methods of shipping spent or irradiated reactor fuel from the HFBR. In addition to this independent report, BNL prepared a spent fuel transportation plan (DOE 1997).

Figure 3.10-1. State and County 1995 Estimated Average Daily Traffic (Two Way Vehicle Volumes)



Source: SECE 1996.

Table 3.10-1. Summary of State and County 1995 Estimated Average Daily Two Way Traffic

Location	Reported 2-Way Vehicle Volume
William Floyd Parkway opposite BNL entrance	22,500
LIE Exit 68	61,500
LIE between Exits 68 & 69	22,000
William Floyd Parkway south of LIE and north of NYS Rte 27	24,700
William Floyd Parkway between NYS Rte 25 & 25A	9,600
County Road 83 north of LIE	46,200
New York State Route 112 north of LIE	22,500
Route 25 between Miller Place-Coram Rd and Wading River Rd	30,600

Source: SECE 1996.

It is assumed that any future transportation methods would be similar to those used when the HFBR was last in operation, and that the spent fuel elements would be transported to DOE's SRS as they have been previously. Transportation of the spent fuel elements would be conducted in accordance with the *High Flux Beam Reactor Spent Fuel Transportation Plan* (DOE 1997), which has been approved by Federal, State, and local officials. The plan contains a communication plan, contacts, stringent shipping container requirements, and a security plan. The plan identifies responsibilities, requirements, and procedures to ensure safe transport of the HFBR spent fuel elements. Transportation of the spent fuel elements and other associated radioactive components would be conducted under this comprehensive plan, which also addresses safeguards, public outreach with local officials (county police, local and state emergency responders, elected officials, town representatives) and civic groups. Integrated into the plan are strict inspection requirements for overland transportation vehicles by U.S. Department of Transportation personnel. At the completion of inspections of overland vehicles, permits would be issued for moving the trucks over public roads. Shipments would occur during the early morning hours under escort by police and BNL security (Holland, et al. 1998).

The plan was developed to minimize potential health risks. For example:

- Typically, spent fuel elements are shipped once every several years in a single shipping campaign. The number of casks shipped in each shipping campaign would be minimized using casks which can hold 42 fuel elements. Thus, the number of overland truck shipments would be minimized.

- The shipping cask meets applicable safety standards set forth in 40 CFR 71 *Packaging and Transportation of Radioactive Materials*. The spent fuel storage cask currently used by BNL for shipment is a steel-encased, lead-shielded shipping cask.

DOE prepared a programmatic environmental impact statement titled *Spent Nuclear Fuel Management Programmatic Environmental Impact Statement* (SNF PEIS) in 1995 (DOE 1995a). The SNF PEIS included an analysis of the potential impacts associated with the transportation of DOE spent nuclear fuel to sites where it would be managed for the next forty years. The SNF PEIS evaluated transportation options for movement of HFBR spent fuel to the SRS and concluded that "no significant impact would result from any combination of port or mode of transport". This conclusion was based on the following findings (DOE 1995a):

- On a nationwide and site-specific basis, the implementation of any of the spent nuclear fuel management alternatives would not significantly contribute to cumulative impacts.

- No transportation related radiological fatalities have ever occurred in the U.S.
- About one traffic accident fatality was estimated to occur over a forty year period (1995 to 2035).

In 1997, which was the last time casks of spent fuel elements were shipped offsite, the casks were transported by truck overland to the former Shoreham Nuclear Power Plant dock where the casks were loaded onto a barge. The barge traveled around the east end of Long Island to the Atlantic Ocean, and then down to Portsmouth, VA. After being offloaded from the barge, the casks were loaded onto trucks which hauled them to SRS in South Carolina for storage pending disposition (DOE 1997).

3.11 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

3.11.1 BACKGROUND TO PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

This section describes the public and occupational health and safety resource area and discusses the affected environment for radiation and chemical hazards. In the interest of presenting the reader with the relevant information in the most practical manner, the discussions in this section are limited to summaries of key information. Additional information and discussions are presented in Appendix C: Health and Safety. To ensure a common understanding of radiation and its impacts on humans, Section C.2.1 of Appendix C describes the nature of radiation, common radiological terms such as “mrem” and “person-rem,” the effects of radiation exposure on humans, and the dose-to-risk conversion factors used for estimating potential latent cancer fatalities.

3.11.1.1 Definition of Resources

Public and occupational health and safety issues include the determination of potentially adverse effects on human health and safety that result from acute and chronic exposures to ionizing radiation and hazardous chemicals. The degree of hazard is directly related to the type and quantity of the particular radioactive or chemical material to which the person is exposed and to the duration of this exposure. The doses from acute or chronic exposures have been converted to potential latent cancer fatalities and noncancer effects. This is done for both normal operations and theoretical accident situations.

3.11.1.2 Approach to Defining Environmental Setting

A description of the current and previous radiological and chemical environments at the HFBR is provided to establish the radiological and hazardous chemical doses that workers and the public may have received from exposures associated with natural background and HFBR operations. These doses may result in health effects. To characterize the HFBR’s operational record, an accident history is presented, past and ongoing health studies of people who work onsite or live in the vicinity are described, industrial hazards are discussed, and the HFBR and BNL emergency management programs are described.

Radioactive releases from BNL and the levels of radioactivity and hazardous chemicals measured in various environmental media (such as air, water, and vegetation) on and around the BNL site are contained in BNL annual reports. Results from these reports were considered in preparing this EIS. In particular, BNL *Site Environmental Reports* for the years 1988, 1995, and 1997 were chosen as the source documents since these were the most recent years that the reactor operated at 60 MW and 30 MW and was shutdown. These years are considered representative because they provide the best available representation of the expected HFBR configuration and operating practices for the various alternatives. The main source of information used to establish existing health impacts to workers, both individual and collective, is the compilation of occupational exposures issued annually by BNL to DOE. Accident histories and the results of epidemiological studies were obtained from many literature sources.

3.11.2 AFFECTED ENVIRONMENT

For public and occupational health and safety, the affected environment is the area within an 80 km (50 mi) radius of the HFBR. The discussion of the affected environment includes regional and site radiation and chemical environments. These topics are discussed with respect to the HFBR.

3.11.2.1 Radiation in the Environment

3.11.2.1.1 *Radiation Sources*

Table 3.11-1 summarizes the major sources of radiation exposure in the vicinity of the HFBR.

In 1997, air sampling was performed to monitor airborne radionuclide concentrations. Monitoring was performed for the analysis of particulates, radioiodines, and tritiated water (HTO) vapor. Naturally occurring radionuclides and tritium were detected most frequently in the collected samples. Gross alpha and gross beta activity levels were consistent with those measured in Albany, NY, a location used as a control area by the New York State Department of Health (NYSDOH) in their state-wide environmental radiation monitoring program.

Table 3.11-2 provides a summary of airborne radionuclides released from the HFBR for the calendar year 1997. These data represent atmospheric radioactive discharges that occurred while the HFBR was shutdown. Using this data, the average dose to an individual within 80 km (50 mi) of the HFBR was estimated to be 1.9×10^{-6} mrem/yr, or 0.0000019 mrem annually. For perspective, Table 3.11-1 compares this dose to other sources of radiation exposure. This table shows that releases from the HFBR constitute an extremely small fraction of the total natural and other background exposure to the public in the vicinity of the reactor.

Since tritium accounts for almost 100 percent of the HFBR airborne releases and because tritium has been of particular interest to the public community surrounding BNL, more detailed information on the sources of tritium is provided below. In 1997, 27 Ci of airborne HTO were released from the HFBR. While this constituted the second largest source of total airborne activity released from BNL, tritium contributed less than one percent of the offsite population dose from all BNL sources (BNL 1999).

Table 3.11-1. Sources of Radiation Exposure to Long Islanders in the Vicinity of the HFBR

Source	Average Dose to an Individual (mrem/yr)	Total Exposure (percent)
Natural Background		
Cosmic	24	6.6%
External	36	9.9%
Internal	40	10.9%
Radon	200	54.8%
Total Natural	**300**	**82.2%**
Other Background		
Diagnostic X-ray	53	14.5%
Weapons test fallout	<1	0.2%
Air Travel	1	0.3%
Consumer products	10	2.8%
Total Other	**65**	**17.8%**
HFBR	**1.9×10^{-6}**	**<<0.1%**
TOTAL	**365**	**100%**

Note: < - less than, << - much less than
Source: BNL 1999, NCRP 1987

Table 3.11-2. Airborne Radionuclides Released by HFBR in 1997 (0 MW)

Radionuclide	Ci Released
H-3	2.70×10^{1}
Rb-84	8.80×10^{-8}
Fe-52	6.49×10^{-8}
Co-60	5.75×10^{-8}
Cs-137	1.93×10^{-8}

Source: BNL 1999.

Tritium is a naturally occurring isotope of hydrogen. Most tritium, however, is artificially produced in nuclear reactors. It has the same chemical properties as hydrogen but is radioactive. Because it is an isotope of hydrogen, it combines with oxygen to form water in the atmosphere and may return to earth's surface as rain or snow.

Tritium emits low-energy beta particles that cannot penetrate surfaces easily and can be stopped by skin, water, glass, aluminum and plastics. However, tritium can pose a health hazard if inhaled, ingested, or absorbed through the skin. Tritium has a radioactive half-life of approximately 12.3 years. This means that in 12.3 years, half of the radioactive nuclei in any amount of tritium will change into stable, nonradioactive helium-3 (He^3). Tritium is a pure beta particle emitter, and the beta energy in tritium is very weak. If tritium gas is inhaled, only a small amount of the gas stays in the body because tritium is rapidly removed through exhalation. However, tritium atoms readily exchange with normal hydrogen in water and the HTO may be retained for longer periods in the body.

HTO interacts with the human body in the same manner as regular water. Whether in vapor or liquid form, HTO water can enter the body through inhalation, ingestion or absorption through the skin. Once inside the body, HTO is distributed throughout the body as regular water would be. HTO remains in the body a relatively short time and is eliminated in the same manner as regular water. Within 10 days, about half of the tritium that has entered the body is naturally eliminated.

Tritium would be and has been released from the HFBR as follows. The HFBR would use heavy water (water containing deuterium, a stable hydrogen isotope that contains one neutron, rather than the two neutrons contained in tritium or no neutrons contained in normal hydrogen) to cool the reactor fuel and control neutrons produced and used in the fission process. Heavy water flowing through and around the core would be exposed to a dense neutron field, and tritium would be produced in the heavy water when deuterium nuclei absorb neutrons. The tritium concentration in the primary cooling water would be dependent upon the reactor power level, the number of days per year that the reactor is at power, and the amount of time elapsed since the last reactor shutdown or coolant change. This, in turn, would determine the amount of tritium that could be released as an airborne or liquid effluent. The primary mechanism by which tritium would be transferred from the interior coolant system to the atmosphere is depressurization of the reactor vessel and evaporative losses during maintenance and refueling operations. Diffusion at valve seals and other fittings would also occur. HTO would be released from the reactor system into the building air exhaust system where it would be routed to the facility's 106 m (350 ft) stack. To keep tritium concentrations and releases as low as possible, the heavy water reactor coolant would be replaced periodically.

Other radionuclides that have been or could also be released from HFBR in very small quantities are typically in the microcurie (μCi) to millicurie (mCi) range depending on reactor power level. These radionuclides are present in reactor coolant systems and can be released through maintenance, equipment operations, and fugitive emissions from equipment such as the storage tank cover gas vents. These releases are within National Emission Standards for Hazardous Air Pollutants (NESHAP) limits.

In addition to the airborne releases discussed above, tritium is also released from the HFBR as a liquid. HTO vapor accumulates at low levels inside the confinement building as a result of fuel handling or other operations, or maintenance activities that require the opening of primary coolant systems. Fugitive emissions from facility components also contribute to routine releases and contamination of nonradioactive water flowing through the sanitary system. Historically, liquid releases of tritium occurred when the building air handling system condensed HTO vapor in the air and also when air came in contact with any systems discharging into the sanitary system. Some of this condensate entered the sanitary waste system and was transported to the STP. In 1995 the discharge from the air conditioners to the sanitary system on the Equipment Level was stopped. The Operations Level condensate discharge was stopped in early 1996. These process changes during 1995 and 1996 constitute a significant change that resulted in permanent reductions of discharges to the sanitary sewage system. Condensate that is collected from areas with elevated background tritium concentrations is used either as makeup water for the spent fuel pool or disposed as liquid radioactive waste. For the last fifteen years or so, the amount of tritium discharged to the Peconic River has decreased from a high of almost 12 Ci in 1984 to less than two in 1996 (Ports 1998c).

Since the Peconic River is not used as a drinking water supply or for irrigation, its waters do not constitute a direct pathway for the ingestion of radioactive material. However, water in the Peconic River does recharge to an underground aquifer that provides water to private wells. Although these wells have been previously used as a water supply for residential homes, these homes now receive their water from the public water system and the wells are no longer used as a residential drinking water supply. Thus the HFBR does not contribute to population doses via the water ingestion pathway.

Although these wells are no longer used as a drinking water supply, analysis of the wells has been performed. Tritium has been the only BNL-related radionuclide detected in any of the private wells associated with the aforementioned underground aquifer. The maximum tritium concentration observed in a residential well in 1997 was 2,201 pCi/l, which is nine times less than the 20,000 pCi/l limit established by the EPA *National Primary Drinking Water Regulations* under the *Safe Drinking Water Act* (SDWA). By calculation, if an individual consumed two liters of water per day from the well with the maximum tritium concentration for all 365 days of the year, the individual would receive a dose of 0.1 mrem.

In addition to air and water sampling, soil and vegetation were collected from offsite locations as part of the Soil and Vegetation Sampling Program, and analyzed for radioactive content. This program is a cooperative effort between BNL and the SCDHS. Samples from local farms situated adjacent to BNL were collected. These samples were analyzed for gamma-emitting radionuclides. No radionuclides attributable to BNL's operations were detected. (BNL 1999).

3.11.2.1.2 *Radiation Doses to the Public from the HFBR*

Table 3.11-3 depicts the impacts to the public for the year 1997, when the reactor was shutdown and thus at zero power.

For purposes of modeling the doses to the maximally exposed individual (MEI) (the hypothetical person who could potentially receive the maximum dose from radiation), all BNL emission points are conservatively assumed to be placed in one location, approximately at the site of the HFBR stack. The location of the MEI is at 3,000 m (9,900 ft) to the north northeast (NNE) from the HFBR stack, which is the location of the nearest residence adjacent to the site boundary in the NNE

Table 3.11-3. Annual Radiation Doses to the Public From HFBR in 1997 (0 MW)

	Standard[a]	Calculated[b]
Population (person-rem/yr)	NS	0.0098
MEI (mrem/yr)	100	8.0×10^{-5}
Average Individual (mrem/yr)	100	1.9×10^{-6}(c)

Note: NS – None specified. The annual doses to the public from the HFBR are received via the atmospheric release pathway.

a The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the limit for airborne emissions as required by the *Clean Air Act* is 10 mrem per year, and the total dose limit from all pathways combined is 100 mrem per year.

b The calculations are based on a population within 80 km (50 mi) of the HFBR of 5,053,187.

c This value was obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the HFBR.

Source: BNL 1999.

direction from the HFBR stack. The MEI was placed at this location because, due to the wind frequency distribution at the BNL site, the maximum dose is consistently projected in the NNE sector. The placement of the MEI at this location is a change from that used in earlier years in BNL *Site Environmental Reports* in which the MEI was assumed to be at the geographically closest boundary (to the west) at 1,500 m (4,900 ft) away. Locating the MEI at 3,000 m (9,900 ft) to the NNE is a better reflection of where the maximum dose would be received. The Clean Air Act Assessment Package-1988 (CAP-88 PC) computer code was used in determining the location of the MEI and demonstrating site compliance (EPA 1992).

Using CAP-88 PC, the effective dose equivalent (EDE) to the MEI from the atmospheric pathway was calculated to be 7×10^{-2} mrem for the year 1997, from all BNL sources. The HFBR was responsible for 8×10^{-5} mrem. Other BNL facilities and buildings that contribute to offsite doses include the Brookhaven Medical Research Reactor (BMRR) (6.9×10^{-2} mrem), the BLIP (7.3×10^{-5} mrem), the Hot Laboratory (1.8×10^{-6} mrem), and the Tritium Evaporator facility (1.3×10^{-5} mrem) (BNL 1999).

CAP-88 PC was again used to calculate population doses from the atmospheric pathway. An offsite population of 5,053,187 was used for this calculation. This calculation determined that the population dose from the atmospheric pathway attributed to the HFBR was 0.0098 person-rem (BNL 1999). As a means for comparison, in 1997 the population dose due to background radiation sources to this population amounted to approximately 1.8×10^{9} person-rem.

3.11.2.1.3 *Radiation Doses to HFBR and BNL Workers*

All personnel who are given access to the HFBR building, even those not directly involved with the facility operations, are required to wear a dosimeter to record radiation exposure. Additionally, personnel provide urinalysis samples if they are required to work in an area with potential airborne tritiated vapor. Personnel who are directly involved with conducting experiments are also subject to some radiation exposure. Because exposure data are collected and maintained for these personnel, they are considered to be the "involved workforce" for this DEIS. Other BNL site personnel who do not enter the HFBR building are considered to be the "noninvolved workforce" for this DEIS.

Table 3.11-4 depicts the radiological impacts to HFBR workers for the year 1997, when the reactor was shutdown.

Table 3.11-4. Radiation Doses to the Worker From Normal Operations in 1997 (0 MW)

Number of workers	64
Collective Dose (person-rem/yr)	6.3
Average worker (mrem/yr)	98
Maximally exposed worker (mrem/yr)	513

Source: NAS 1990, Reciniello 1998.

Specific analyses to determine the radiological doses to the noninvolved workforce from routine HFBR operations have not been performed. However, an analysis of the worst weather conditions has been performed (Karol 1998) that can be used to estimate that, under very conservative conditions, the maximally exposed noninvolved worker would receive a dose about 3 times greater than the MEI dose from the atmospheric release pathway. Thus, for 1997, the maximally exposed noninvolved worker was estimated to have received an annual dose of $2.4x10^{-4}$ mrem.

In addition to HFBR workers, HFBR experimenters also receive doses while performing experiments at the HFBR. These experimenters may be BNL employees or associated with an external entity such as a university. Doses to these individuals are tracked separately from HFBR workers and, on average, are much lower than the annual doses received by HFBR workers. Because (1) individual doses to experimenters depend more on the nature of the experiments than the reactor power level, (2) the collective dose to experimenters depends more on the number of experiments that are conducted in a year than the reactor power level, and (3) exposures to involved workers should bound any expected exposures to experimental staff, discussions concerning the doses expected to be received by experimenters for each alternative are not presented in this EIS. The annual doses of a small sample of experimenters for which data are available have ranged from 10 mrem/yr to 80 mrem/yr (Holeman 1998).

3.11.2.2 Chemicals in the Environment

As a research facility, the HFBR does not have a standard set of chemicals or quantities which are normally present within the complex. With the exception of standard industrial processes, such as cooling water chemistry control, air conditioning, industrial solvents, and lubricants, most of the chemicals are used and stored in a laboratory setting, where relatively small quantities of hazardous chemicals are used on a non-production basis. Changing research requirements have in the past, and will in the future if the HFBR is restarted, necessitate the introduction of new substances. The hazards associated with each new chemical introduced to the HFBR complex will be evaluated on a case-by-case basis.

The chemical environment in the region surrounding BNL is described by the background chemical data obtained from soil samples and may be affected by BNL activities that may produce hazardous/toxic wastes. No activity at the HFBR was found to use chemicals in quantities that may pose substantial risks to humans or the environment.

Soil and vegetation samples are routinely collected from offsite locations as part of the Soil and Vegetation Sampling Program and analyzed for radioactive and metal content. This program is a cooperative effort between BNL and SCDHS. The nonradiological analyses performed showed that the parameters tested for and concentrations observed were typical of values noted in background soil samples on site.

In order to determine the non-radiological hazards of concern at the HFBR, a detailed hazard analysis was performed as part of the HFBR Safety Analysis Report upgrade (BNL 1998h). The following is a short discussion of the process utilized in the consideration of nonradiological hazard assessment and consequence estimation.

The BNL Chemical Management System (CMS) was used to determine the types and quantities of hazardous chemicals in use at the HFBR complex. The Environmental Safety and Health Division developed and maintains the CMS to comply with Occupational Safety and Health Administration (OSHA) and EPA regulations concerning hazardous chemical communication. The CMS is augmented by the BNL Plant Engineering Division Tank List and the HFBR Local Emergency Plan which focus on the bulk storage of chemicals, fuels, compressed and flammable gases, and other hazardous substances.

The Hazard Analysis used three screening criteria to assess the hazards of chemicals used and stored within the HFBR complex:

The first screening criteria is based on the *Process Safety Management Rule*, 29 CFR 1910.119, which contains requirements for preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. The rule is applicable to processes that involve chemicals at or above specified threshold quantities (TQs). The TQ is the amount of a specific chemical that represents a potential for a catastrophic event if a release should occur. The screening value used at the HFBR was set at 50 percent of the TQ quantity.

The second screening criteria is 50 percent of the threshold planning quantities (TPQs) for extremely hazardous substances of 40 CFR 355, *Emergency Planning Notification*. This regulation establishes the list of extremely hazardous substances, threshold planning quantities, and facility notification responsibilities necessary for the development and implementation of state and local emergency response plans. Substances on this list and present in the facility at or in excess of their TPQs are subject to emergency planning.

The third screening criterion uses 40 CFR 302, *Designation, Reportable Quantities, and Notification*. This regulation designates reportable quantities (RQs) and sets forth the notification requirements for releases of hazardous substances designated under the CERCLA or Section 311(b)(2)(A) of the *Clean Water Act* (CWA). Hazardous materials releases to the environment of the substances listed in Table 302.4 of the regulation require notification to the National Response Center. This third screening criteria was also set at 50 percent of these reportable quantities.

Table 3.11-5 depicts the inventory of chemicals and other nonradiological hazards that can be found at the HFBR.

The sulfuric acid is stored in a tank that has a capacity of approximately 7,600 l (2,000 gal) located on the south side of the water treatment house (Building 707B). An overfill alarm is provided as an additional means to alert the operators of potential danger. The tank is inspected daily and alarm tested periodically. The tank has a secondary containment dike. The sulfuric acid is 95 percent pure and is used to control the pH of the secondary water cooling system. The tank is normally filled once a year. During the filling operation, two persons are always present monitoring the transfer.

Catastrophic failure of the whole tank into the diked area would vaporize very slowly resulting in environmental consequences that would be negligible. The concrete dike is designed to contain any spill up to and including 110 percent of the tank's capacity and it would serve to prevent the chemical entering the soil or groundwater. The only remaining potential exposure pathway is inhalation, but the spill of the sulfuric acid is not an airborne hazard because of the low evaporation rates. The only emergency declaration from this event would be a Base Operational Emergency (see Section 3.11.2.6).

A water-based corrosion inhibitor for the Secondary Cooling Water System is stored in an outdoor tank. This chemical is a proprietary formulation that contains potassium hydroxide. The 7,600 l tank capacity exceeds the screening criteria for potassium hydroxide. This tank, which has secondary containment, is located adjacent to a second tank containing another

Table 3.11-5. Identification of Chemical and Other Nonradiological Hazards at the HFBR

Material	Regulatory Threshold	Screening Amount	Amounts Within the HFBR Complex
Chemicals			
Sulfuric acid	454 kg	230 kg	7,600 l (14,000 kg)
Secondary Water Corrosion Inhibitor [(1)]	11,300 l	5,650 l	7,600 l
Lithium Chromate Inhibitor	4.5 kg	2.2 kg	10 kg
Lithium Arsenite Inhibitor	0.45 kg	0.23 kg	3.6 kg
Cadmium Nitrate (in solution)	[(2)]	[(2)]	1,500 kg
(powder)	[(2)]	[(2)]	91 kg
Flammables and Explosives			
Propane	NA	NA	3,800 l
Beamline neutron detectors[3]	NA	NA	Several
Hydrogen	NA	NA	Varied amounts
Welding gases	NA	NA	Varied amounts
Asphyxiants			
Fire suppression system	NA	NA	Varied amounts
Process gases	NA	NA	Varied amounts

NA - Not Applicable
(1) Based on potassium hydroxide concentration
(2) There is no RQ, TQ, or TPQ for cadmium nitrate. It is included because it can release toxic oxides of cadmium under high temperatures.
(3) Several beamline experiments use small amounts of flammable gases within their neutron detectors.
Source: BNL 1998g.

water treatment chemical. The tank is equipped with an overfill alarm and most of the system piping is heated to prevent freezing. Any breach of the tank would result in the chemical being contained in the concrete dike. Should both tanks be breached when filled to capacity, approximately 3,800 l (1,000 gal) would overflow the dike and be released into the environment. Even if this leakage were to consist entirely of secondary water inhibitor, it would still be less than 50 percent of the 40 CFR 302 RQ of the material. Furthermore, the manufacturer has stated that the evaporation rate of this inhibitor is low, and similar to the evaporation rate of water. Thus, there is no credible inhalation exposure pathway to the public. Consequences of a tank rupture are negligible, and the environmental consequences are judged to be low for the simultaneous failure of both tanks.

Both lithium chromate and lithium arsenite are used as corrosion inhibitors in the absorption machines that produce chilled water for confinement building air conditioning. The self-contained chiller units are located on the Equipment Level. The working fluid, containing the inhibitors, is completely contained within the machines. The two corrosion inhibitors are used by two different units. A potential release mechanism for both units is leakage through a fitting. However, the floor drain system, the sumps, and the Equipment Level floor joints are being upgraded to conform to Suffolk County Sanitary Code, Article 12 to assure that leakages of this type will not enter the groundwater. The unit that has the lithium arsenite corrosion inhibitor uses higher pressure steam (approximately 150 psi) and has an additional postulated release mechanism. A catastrophic break of a steam tube compounded by a failure of the safety logic could overpressurize the unit, open the unit's rupture disk and ultimately release some of the working fluid from the HFBR stack. Since this inhibitor is not volatile it can only be transported in water droplets. The confinement building ventilation piping and filters would retain most of the inhibitor. Public health impacts from a lithium arsenite release are judged to be low, and offsite protective actions are not required.

A light water and cadmium nitrate solution is used as an alternative means of reactor shutdown. The system is known as the "poison water system" because its injection "poisons" the fission process shutting down the reactor. The 1,500 l (400 gal) stainless steel poison water tank is located on the operations level of the HFBR within a sheet metal enclosure known as the "Greenhouse". The tank contains approximately 1,500 kg (3,300 lb) of cadmium nitrate. Approximately 91 kg (200 lb) of cadmium nitrate powder is also stored within confinement which can be used to replenish system losses due to periodic sampling. Since the cadmium nitrate does not have RQs, TQs, or TPQs, it does not exceed the screening criteria.

The cadmium nitrate tank is located within a bermed area that occupies a large portion of the Greenhouse floor area. The berm directs any leakage from the poison water tank into the reactor cavity from where it can reach the equipment level. There, the floor drain system, the sumps, and the floor joints are being upgraded to conform to Suffolk County Sanitary Code, Articles 7 and 12 to assure that leakages of this type will not enter the environment.

The cadmium nitrate powder is stable under normal temperatures and pressures. The compound can decompose when subject to heat, releasing toxic oxides of cadmium. These oxides in turn have very high melting points (900 °C [1650 ºF]), so any release is expected to be particulate matter. In the event of a release within the building, the confinement building ventilation filters and the confinement itself are expected to retain most of the particulates. It is concluded that in this event offsite protection is not required.

There is a 3,800 l (1,000 gal) underground storage tank for the propane located approximately 90 m (300 ft) north of the confinement building. The top of the tank is about a half meter (24 in) below grade. In the event of an unconfined vapor cloud explosion, the resulting overpressure could damage the confinement building . However the frequency of such an accident can be shown to be less than once in a million years.

Several experimental beamline configurations use neutron detectors that contain small quantities of flammable gases such as propane, hydrogen, and methane. The gases could be released if overpressurization or failure of the detector were to occur. Programs are in place to control the types and quantities of flammable gases to ensure that reactor safety will not be degraded, no significant environmental releases will occur, personnel safety will be maintained, and that experiments on adjacent beamlines will not be significantly damaged.

Hydrogen is a well known explosive hazard. It is used and stored in the HFBR complex in support of the Cold Neutron Facility (CNF). The CNF uses cold neutrons to study the structure and dynamics of matter in the condensed state. Liquefied hydrogen is used in a specially designed moderator chamber to significantly increase the flux of cold neutrons that are available for experimental purposes. Hydrogen cylinders are stored outside of the confinement in outdoor storage racks. The storage areas are fenced and locked to control access. An analysis used to predict potential overpressures from flammable gas ignitions showed that gaseous hydrogen, regardless of system pressure, does not present a significant or credible outdoor vapor cloud explosion hazard.

Gases such as acetylene and propylene are used within the HFBR for cutting and welding activities. Administrative controls are in place to assure that any postulated accident will not affect reactor safety.

Halon 1301 and carbon dioxide are used within the HFBR complex as part of the fire suppression system. The Halon is used to protect the console and instrumentation panels in the HFBR control room, while the carbon dioxide system is provided within the HFBR confinement system to ensure that in the event of a fire, light water is excluded from certain critical areas of the equipment and operational levels. The use of Halon to extinguish control room console and panel fires is considered a standard industrial hazard while the carbon dioxide system can be used by the operators or the BNL fire group, if required. Portable fire extinguishers are considered the first line of defense against fires.

The process gases consist of liquid nitrogen, carbon dioxide gases, and the helium supply systems. Although they present asphyxiation threats to personnel, they are considered standard industrial hazards.

There are other sources of hazards at the HFBR not included in Table 3.11-5. They include natural energy sources (like earthquakes and tornadoes) and manufactured sources (like aircraft impacts, compressed gases and such). Without exception, they are standard industrial hazards or of such low likelihood of occurrence that they would be of little or no consequence. More information on industrial hazards is provided in the next section.

In addition, multiple programs have been instituted at the HFBR to ensure worker safety in accordance with the "Defense In Depth" philosophy. Existing programs that address criticality safety, radiation protection, hazardous material protection, institutional safety, training and procedures, operational safety, and emergency preparedness are in place and deemed to provide sufficient assurance of worker safety.

It can be concluded from the above discussion that although there are chemicals in use at the HFBR, worker and public safety is assured through use of procedures, limiting quantities and by enforcing programs that are designed to protect safety.

3.11.2.3 Industrial Hazards

Industrial hazards are not analyzed in detail as part of this EIS, but certain industrial hazards are encountered with any large industrial operations and must be considered for all alternatives. Hoisting and lifting is an industrial hazard that will be encountered primarily with the Resume Operations and Enhance Facility Alternative because it involves revesseling operations and to a lesser extent under the No Action Alternative and the Permanent Shutdown Alternative. Primary industrial hazards are described below.

Hoisting and Lifting: The HFBR complex has cranes, hoists, and assorted lifting equipment that are used to move heavy loads up to 20 tons within the facility. A total of four cranes are available for handing heavy loads on the equipment level. An overhead crane and a reactor pit hoist are located on the operations level. A CNF crane services Building 751. Fork lift trucks and low lift platform trucks are used to transfer loads between reactor building floors via the freight elevator. Personnel safety during hoisting and lifting operations is considered to be a standard industrial hazard which is minimized by administrative controls (BNL 1998g).

Electrical Shock: The HFBR electrical power system steps down the incoming commercial 13.8 kV power to 2.4 kV and distributes it throughout the complex. Local transformers reduce the voltage to power the various building loads. Portions of the system are also powered by the backup generator. The DC electrical power system provides an independent source of power at voltages up to 250 Vdc for the operation of important electrical control and reactor safety circuits and equipment. In addition to the potential effects on reactor operation, the electrical power system is a source of energy that is a recognized personnel hazard. The Reactor Division has a formal system of controlling work on electrical equipment to ensure that personnel safety is not degraded (BNL 1998g).

Noise: The noise level in much of the HFBR complex is relatively low, as established by periodic noise surveys. High noise areas are posted. The major sources of noise (for example, the primary and secondary pumps, backup generator, building exhaust blowers, and the CNF helium refrigeration compressor) are located in areas that are not continuously occupied. Hearing protection is required when personnel are in high noise environments. BNL maintains procedures for noise level management (BNL 1998g).

Confined Spaces: A variety of hazards associated with confined spaces have been identified within the HFBR complex. These spaces range from relatively benign valve pits to potentially more hazardous storage tanks equipped with walkways. Administrative procedures delineate the safe work practices that are necessary to ensure personnel safety, including inventory and classification of confined spaces, procedure controls, posting of signs, and training (BNL 1998g).

Lasers: Lasers are used within the HFBR complex, typically to align experimental configurations. Lasers are a standard industrial hazard which are administratively controlled by procedure (BNL 1998g).

Heat: Work conditions within the HFBR are frequently evaluated and work assignments are planned to minimize the effects of heat stress. Procedures are maintained for protection of all personnel (BNL 1998g).

Steam System: The HFBR uses low pressure steam (pressures up to 150 psi) for space and water heating, space cooling and humidification. Personnel safety in the vicinity of steam systems is considered to be a standard industrial hazard that is minimized by administrative controls (BNL 1998g).

Operations at the HFBR expose workers to the industrial hazards listed above during the normal conduct of their work activities. Occupational safety and health training that includes specialized job safety and health training appropriate to the work performed is provided for all employees at the HFBR.

Even with these safety and health programs in place, some occupational incidents or accidents will likely occur. It is expected that these accidents will be comparable in frequency and severity to those expected to occur at a large industrial facility.

3.11.2.4 Health Effects Studies

Two recent epidemiological studies of the communities surrounding BNL have been performed. One study focused on breast cancer incidence rates (Sternglass 1994), while the other study investigated the incidence rates of a number of different types of cancers and congenital malformations (Grimson 1998). For the remainder of this section, these studies will be referred to as the “Sternglass study” and the “Grimson study.”

The Sternglass study found that the breast cancer incidence rate for all the community groups within 24 km (15 mi) of BNL was about 11 percent higher than Suffolk county as a whole. The Grimson study, which included consideration of the results of the Sternglass study, found that the cancer rates for the population living in the area surrounding BNL are not elevated in comparison with the cancer rates in other regions of New York state. The study did find that the incidence rate of female breast cancer on the east end of Long Island (greater than 24 km [15 mi] east of BNL) was significantly higher than the rates of the areas adjacent to BNL. The study noted that the reason for this increase has not been specifically identified. More details with regard to these, and other, epidemiology studies can be found in Appendix C, Section C.4, Human Health Effects Studies: Epidemiology.

3.11.2.5 Accident History at HFBR

No accidents leading to significant external airborne releases have occurred at the HFBR. There have been occurrences leading to minor contamination inside the confinement building, to which emergency response teams have been summoned (see Appendix C, Section C.5). These have typically involved experimental facilities having design features making them susceptible to failures which could release contamination. These experimental facilities were either removed or upgraded to correct the problem, and procedures for safety review of experimental facilities have since been enhanced to help minimize this type of event.

There have also been several spills of tritium-contaminated water inside the confinement building, the most serious of which involved the spill of approximately 570 l (150 gal) of tritiated reactor primary coolant water onto the floor of the Equipment Level when a pump shaft seal came apart (DOE 1995b). Only a small quantity of this water is believed to have escaped from the building by leakage into the ground. No administrative limits on water discharge from the site were exceeded as a result of this incident. Corrective actions were taken to prevent recurrence of the loosening of the pump shaft seal, and to better contain any future spills of tritiated water within the confinement building.

In January 1997, it was discovered that a leak from the unlined spent fuel pool had permitted substantial amounts of water carrying tritium to leak into the ground. Samples revealed tritium in the groundwater above the EPA drinking water standard. All items stored in the spent fuel pool have been removed and the water has been pumped out and stored safely elsewhere onsite. Section 1.8 provides more details on this leak and associated recovery actions.

It should be noted that environmental monitoring results indicated that none of the levels of gaseous or liquid effluents emanating from the HFBR during any of these incidents have ever exceeded Federal guidelines or limits on offsite releases designed to protect the health and safety of the public.

3.11.2.6 Emergency Preparedness

BNL and the HFBR have established an emergency management program that would be activated in the event of an accident involving the release of radiological or other hazardous materials. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

DOE emergency preparedness plans and procedures for BNL and the HFBR support onsite and offsite emergency management actions in the event of an accident (BNL 1995b, BNL 1997f). The HFBR Local Emergency Plan is integrated with the overall BNL *Laboratory Emergency Plan*. BNL also provides technical assistance to other Federal agencies and to State and local governments. BNL is responsible for ensuring that emergency plans and procedures are prepared and maintained for all facilities, operations, and activities under their jurisdiction, and for directing implementation of those plans and procedures during emergency conditions. BNL and State and local government plans are fully coordinated and integrated.

In trying to ensure that all BNL facilities and operations develop and maintain emergency planning, preparedness, and response capabilities, BNL has developed the *Brookhaven National Laboratory Hazard Assessment*, Revision 1, dated December 1997 to implement the requirements of DOE Emergency Management Guide 151.1, *Guidance For A Hazard Assessment Methodology*, dated August 21, 1997.

The emphasis in the hazard assessment is on airborne release of toxic and radioactive materials that could pose a threat to onsite and offsite personnel. The process uses a screening step whereby small quantities of materials commonly used in science and industry were excluded from detailed consideration. The assessment includes an identification of types and quantities of hazardous materials used and stored at BNL and the HFBR. For toxic materials, the TPQs as defined in the *EPA Superfund Amendment and Reauthorization* (SARA*) Title III*, 40 CFR Part 355, Appendix A are used. After hazard identification, hazard characterization was performed, followed by event scenarios, and ultimately, consequence estimation.

Estimated consequences of potential accidents and events were examined to determine whether they required protective actions either onsite or offsite. Three potential exposure modes were considered.

- The first exposure mode, ingestion of hazardous materials, and the second exposure mode, dermal (absorption through the skin) exposure to hazardous materials of sufficient quantities to harm an individual, are only significant in the very near vicinity of the accident (for example, within the room or facility where the accident occurs). This is important because it helps in defining industrial safety measures and in the development of local facility emergency plans.

- The third exposure mode, inhalation, involves hazards under pressure or other materials with high vapor pressures.

As a result of the event scenarios and consequence assessment, emergency classifications ranging from Base Operational Emergency to General Emergency were established. These emergency classifications differ in severity and in the type of response needed to protect workers, the public, or the environment.

Short definitions of the Emergency classifications established at BNL are provided below:

- Base Operational Emergency: An event in progress or having occurred which involves an actual or potential reduction in the safety or security of the facility with actual or potential direct harm to people or the environment.

- Alert: An event or events that are in progress or have occurred which involve actual or potential significant reductions in the level of facility safety and protection. Environmental releases of hazardous materials are expected to be limited to small fractions of the appropriate Protective Action Guidelines (PAG) or Emergency Response Planning Guidelines (ERPG) onsite.

- Site Area Emergency (SAE): An event or events that are in progress or have occurred involving an actual or likely failure(s) of facility safety or safeguards systems needed for the protection of onsite personnel, the public health and safety, the environment, or national security. Environmental releases of hazardous materials are not expected to exceed the appropriate PAG or ERPG exposure levels offsite.

- General Emergency (GE): An event or events which are in progress or have occurred that involve the actual or imminent catastrophic failure of facility systems with potential for loss of confinement integrity or catastrophic degradation of facility protection systems, which could lead to substantial offsite impacts. Environmental releases of hazardous materials can reasonably be expected to exceed the appropriate PAG or ERPG exposure levels offsite (BNL 1997e).

The emergency classifications are consistent with DOE emergency classes and the BNL Emergency Plan. For chemical hazards, no Emergency Action Level (EAL) more serious than Alert is projected for the HFBR. For radiological hazards, the most serious EAL is projected to be the Site Area Emergency (BNL 1997e).

3.12 WASTE MANAGEMENT

3.12.1 BACKGROUND TO WASTE MANAGEMENT

3.12.1.1 Approach to Defining Environmental Setting

Waste generation at BNL and at the HFBR, and BNL waste management storage capacities have been evaluated using records from the Waste Management Division and the HFBR, permits and compliance agreements as well as communications with BNL personnel. This information is used to describe the current conditions and to evaluate potential impacts of each of the proposed alternatives.

Data for the HFBR was provided by the Reactor Division Waste Coordinator (Kneitel 1999). Waste generation data from the five-year period between 1993 and 1997 was used to determine the average waste generation rates for operation of the HFBR including its research facilities. Communications with HFBR personnel was used to estimate and predict the waste generation for each of the proposed alternatives.

BNL solid waste storage capacities are based upon the permitted capacities of the new Waste Management Facility (WMF) which opened in 1997 (BNL 1997a). Solid waste storage facilities include Buildings 855, 865, and 870. Liquid waste is stored and processed in Buildings 801 and 811.

Waste minimization and pollution prevention plans are implemented at BNL to reduce waste generation from all BNL operations. Pollution prevention is incorporated into all BNL operations at the earliest feasible stage of a project. BNL outlines waste minimization goals in the *Waste Minimization and Pollution Prevention Awareness Plan* (BNL 1994, BNL 1996f). To report progress toward the goals outlined in the plan, BNL prepares the *Waste Generation and Waste Minimization Progress Annual Report*. These reports were used to determine BNL waste generation data for the five-year period between 1993 and 1997.

In addition to reducing waste generation through waste minimization and pollution prevention, BNL is in the process of resolving waste generated from past operations. DOE has been working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from past operations at BNL (DOE 1994). To achieve regulatory compliance, DOE has committed to perform activities set forth in negotiated agreements by specified dates.

For example, on March 23, 1998, DOE and EPA signed a Memorandum of Agreement (MOA) regarding the operation and environmental management of BNL including the HFBR. The MOA states, “It is both EPA’s and DOE’s objective that BNL be operated so as to maintain full compliance with applicable environmental requirements, and to protect the environment and the health and safety of the workers at the facility and the general public.” The MOA contains two attachments, the “Process Evaluation Agreement” and the “Environmental Management Systems Audit”. These attachments outline plans to determine the regulatory status of BNL wastes, to ensure all personnel are familiar with proper waste management and handling procedures, to ensure waste minimization and pollution prevention plans are analyzed and implemented, and to develop a five year audit program to measure BNL’s success in achieving full compliance with regulatory requirements (DOE 1998).

HFBR personnel track waste generation and routinely evaluate activities to identify measures that can be implemented to reduce waste generation. These efforts are summarized in annual reports from the Reactor Division Waste Coordinator to the Reactor Division Environment, Safety and Health Committee (Kneitel 1999).

Regardless of the alternative selected by DOE, future waste minimization and pollution prevention measures may further reduce actual waste generation rates compared to the estimates discussed in this analysis.

3.12.2 AFFECTED ENVIRONMENT

3.12.2.1 Waste Management at Brookhaven National Laboratory

BNL generates the following types of wastes: spent nuclear fuel, solid and liquid low-level radioactive wastes (LLW), hazardous wastes, mixed wastes, and industrial wastes.

All solid wastes are stored at the WMF, which is permitted to manage wastes (BNL 1997a). All wastes generated at BNL are managed using appropriate storage, handling, and labeling practices in compliance with Federal, State and local statutes and DOE Orders.

BNL does not treat or dispose of any solid wastes generated onsite. All non-sanitary solid wastes are shipped offsite to approved facilities for treatment and final disposition. BNL has the ability to process liquid wastes onsite prior to shipment offsite or to evaporate some liquids onsite.

In accordance with DOE Order 430.1A *Life Cycle Assessment Management*, it is the goal of the WMF to hold waste for no longer then one year before it is transported offsite to an approved facility for disposal.

3.12.2.2 Spent Nuclear Fuel

Spent nuclear fuel (SNF) is fuel that has been withdrawn from a nuclear reactor following irradiation. The elements that constitute nuclear fuel have not been separated from the fission products created during irradiation. Even though DOE is no longer reprocessing SNF solely to recover fissile and fertile material, SNF is not characterized as waste from a regulatory perspective. However, since it is a radioactive material that must be stored, handled, and managed it is included here for completeness.

SNF elements are generated by operation of the HFBR. Each new HFBR fuel element contains approximately 351 grams (approximately 0.75 lb) of highly enriched uranium (HEU). (HEU is defined as containing more than 20 percent U^{235}.) When the elements are removed from the reactor vessel at the end of each operating cycle, they still contain an average of 191 grams (approximately 0.42 lb) of HEU (BNL 1998i). The spent fuel elements are moved to the spent fuel pool and after a sufficient cooling off period, the top and bottom non-fuel containing portion of the fuel element is cut off. These “cut-ends” are disposed of as LLW. The portion of the spent fuel element that contains the fissile material is placed in storage racks in the fuel pool prior to being shipped offsite (DOE 1995c).

Operation of the HFBR at 30 MW typically generates no more then 63 spent fuel elements each year based on an average of nine operating cycles annually with seven elements replaced between each cycle. Additionally, the entire core (28 elements) is discharged approximately once every five years (for 60 MW operation) to eight years (for 30 MW operation) to facilitate material surveillance of the reactor vessel.

As discussed in Section 2.3.5, there is a modification currently underway to install a double walled stainless steel liner in the spent fuel pool. The upgraded spent fuel pool is expected to have a capacity of approximately 1,000 fuel elements.

3.12.2.3 Low Level Radioactive Waste

Radioactive waste that is not SNF, high level waste, transuranic waste, or byproduct material as defined by DOE Order 5820.2A, *Radioactive Waste Management*, is classified as LLW.

Solid and liquid LLW is generated by various routine operations. Environmental restoration operations are the primary source of non-routine solid LLW and this is expected to increase as cleanup operations intensify over the next several years (BNL 1998c).

Solid LLW is stored in the WMF Building 865. This facility has a permitted capacity to store 540 m^3 (19,000 ft^3) of solid LLW provided it operates within the nuclide limits defined for a Category 3 Non-Reactor Nuclear Facility. A compaction device, scheduled to begin operation in 1999, will greatly reduce the volume of solid LLW that must be stored prior to disposal. On average about 325 m^3 (11,400 ft^3) of solid LLW was generated annually between 1993 and 1997 by routine operations at BNL. Most solid LLW generated at BNL is transported within one year to DOE's Hanford site for treatment and disposal (BNL 1997g).

Bulk liquid LLW is stored and processed in Buildings 801 and 811. The storage capacity of the tanks at these buildings is 340 m^3 (90,000 gal), however administrative limits are imposed which reduce the allowable storage capacity to 265 m^3 (70,000 gal). It should be noted that provisions are in place to procure additional storage capacity as required. Liquid LLW generated at BNL is processed using reverse osmosis to separate the solids. The sludges generated are shipped offsite to an approved facility for disposal. The processed liquid is then evaporated. Some liquid waste generated at BNL is not processed and is shipped for offsite to an approved treatment and disposal facility. Between 1993 and 1997 an average of about 115 m^3 (30,000 gal) of liquid LLW was generated annually at BNL.

During the same five-year period the HFBR generated on average 37 m^3 (1300 ft^3) of solid LLW annually (Kneitel 1999). This is approximately 10 percent of the solid LLW routinely generated at BNL each year. Most of the solid LLW generated at the HFBR is in the form of dry compactable waste, made up of used protective anti-contamination clothing (gloves, booties, coveralls, tape) or other items used during fuel handling, monitoring, surveillance, maintenance and other operations conducted in contaminated areas. In general, the volume of LLW generated is directly proportional to the amount of maintenance work performed. In addition, non-compactable wastes such as cut fuel ends, aluminum tubing, and other metal items are also routinely generated as a result of operations and research activities.

The HFBR generates approximately 80 m^3 (21,000 gallons) of liquid LLW annually, based on the five-year average (1993-1997) (Kneitel 1999). This is approximately 70 percent of the liquid LLW generated at BNL. Historically, the largest source of liquid LLW generated at the HFBR has been the contaminated water that results from regeneration of the resin beds used for the purification of the spent fuel pool water. Mixed resin columns are used to filter the spent fuel pool water, and periodically the resin must be rinsed with acid and caustic to regenerate it. Other sources of liquid LLW include purge water from samples, water from the air compressor oil separator and potentially contaminated mop water. Recently, an effort to reduce the amount of tritium released to the sanitary system has resulted in more sources of water being collected and processed as liquid LLW. For example, condensate from air conditioners and air handlers in the HFBR is now collected and processed as liquid LLW. When the new fuel pool liner is installed, some of this water may be used as a makeup water supply and will no longer be processed as liquid LLW.

In 1997 a one-time non-routine increase in liquid LLW resulted from draining approximately 260 m^3 (68,000 gallons) of contaminated water from the spent fuel pool (BNL 1998e). The spent fuel pool water is currently contained in new storage tanks at Building 811 and in temporary storage tanks at the WMF.

3.12.2.4 Mixed Waste

"Mixed waste" is waste that contains both hazardous and radioactive constituents. The mixed wastes generated at BNL are from operations that create radioactive-contaminated materials or activated hazardous materials such as metals, chemicals, and solvents. Mixed wastes generated at the HFBR include liquid wastes generated by the analytical chemistry laboratory (from routine samples of the HFBR water systems) and oils or rags that become contaminated with solvents (during maintenance of pumps and other equipment). Occasionally lead bricks or other contaminated heavy metals are disposed as mixed waste.

Mixed wastes are stored in the WMF Building 870, which has a permitted capacity of 19 m^3 (5000 gal) (BNL 1998h). All mixed wastes generated at BNL are shipped to various approved treatment and disposal facilities (BNL 1997h). From 1993 to 1997 an average of 8 m^3 (285 ft^3) of mixed waste was generated each year at BNL. Based on the five-year average (1993-1997), the HFBR generates on average about 1.7 m^3 (60 ft^3) of mixed waste annually (Kneitel 1999). This accounts is approximately 25 percent of the total mixed waste generated each year at BNL.

3.12.2.5 Hazardous Waste

Non-radioactive wastes that have characteristics identified by one or both of the following Federal statutes: *The Resource Conservation and Recovery* Act (RCRA) (40 CFR 26.1) as amended or *The Toxic Substances Control Act* (TSCA) are classified as "hazardous wastes". These include substances that are toxic, corrosive, reactive, ignitable, or that have been identified as posing health or environmental risks. Hazardous wastes include chemicals, leaded oils or paints, solvents, sludges, acids, organic solvents, heavy metals and pesticides.

Hazardous wastes are generated at BNL from various large-scale research and laboratory facilities as well as from maintenance operations (BNL 1996f). Hazardous wastes are stored at the WMF in Building 855, which has a permitted storage capacity of 117 m^3 (31,000 gal). All hazardous wastes are packaged and shipped offsite for treatment and disposal (BNL 1996e, BNL 1997h). Between 1993 and 1997 an average of 215 metric tons (474,000 lb) of hazardous waste was generated at BNL annually.

Based on the five-year average (1993-1997), the HFBR generates on average approximately 1 metric ton (2,205 lb) of hazardous waste, which equaled an approximate volume of 2.4 m^3 (85 ft^3) of hazardous waste annually (Kneitel 1999). This is less than one half of 1 percent of all hazardous waste generated at BNL. Hazardous wastes generated at the HFBR primarily include batteries, lead, acids and other chemicals or solvents, or rags and protective clothing contaminated with hazardous waste.

3.12.2.6 Industrial Waste

Some wastes are State-regulated or otherwise not appropriate for disposal in the municipal landfill. These are solids or liquids that are non-radioactive and not defined as hazardous materials under RCRA or TSCA, but are considered hazardous by some States.

Industrial wastes are sent to the WMF for temporary storage prior to offsite disposal. There are no regulatory permit requirements associated with industrial waste storage, therefore there are no storage capacity constraints. Industrial wastes generated at BNL consist primarily of oils and oil-contaminated rags, debris and soils. Industrial wastes are transported offsite to designated facilities by contract vendors for treatment and disposition (BNL 1994).

The HFBR generates less than 1 percent of all industrial wastes generated at BNL.

3.13 ENVIRONMENTAL JUSTICE

3.13.1 Definition of Resource

EPA's Office of Environmental Justice offers the following definition of Environmental Justice:

> The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.

The goal of this "fair treatment" is not to shift risks among populations, but to identify potential disproportionately high and adverse effects and identify alternatives that may mitigate these impacts.

Pursuant to Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, environmental justice analyses identify and address any disproportionately high and adverse human health or environmental effects on minority or low-income populations from the alternatives included in this EIS. Adverse health effects may include bodily impairment, infirmity, illness, or death. Adverse environmental effects include socioeconomic effects, when those impacts are interrelated to impacts on the natural or physical environment.

3.13.2 Defining Environmental Setting

Environmental justice guidance developed by the CEQ defines “minority” as individual(s) who are members of the following population groups: American Indian or Alaskan Native, Asian or Pacific Islander, Black, or Hispanic (CEQ 1997). Minority populations are identified when either the minority population of the affected area exceeds 50 percent or the percentage of minority population in the affected area is meaningfully greater than the minority population percentage in the general population in the surrounding area or other appropriate unit of geographical analysis. Low-income populations are identified using statistical poverty thresholds from the Bureau of Census’ “Current Population Reports, Series P-60 on Income and Poverty” (defined in 1990 as income less than $13,359 for a family of four).

Environmental justice impacts become issues of concern if the proposed activities result in disproportionately high and adverse human and environmental effects to minority or low-income populations. Disproportionately high and adverse human health effects are identified by assessing these three factors to the extent practicable:

- Whether the health effects, which may be measured in risks or rates, are significant (as defined by NEPA) or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death.
- Whether the risk or rate of exposure to a minority population or low-income population to an environmental hazard is significant (as defined by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.
- Whether health effects occur in a minority population or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

Any disproportionately high and adverse human health effects on minority populations or low income populations that could result from the HFBR alternatives being considered are assessed for an 80 km (50 mi) area radius around the site, the area which health effects are assessed. Impacts from other resources would also be bounded by this area. Socioeconomic impacts associated with environmental justice concerns are assessed for the two-county ROI described in Section 3.9.

3.13.3 Affected Environment

As seen in Figures 3.13-1 and 3.13-2 and Table 3.13–1, the ROI contains a relatively small racial minority population. In 1990, the ROI population was 88.4 percent white compared to 74 percent for the State of New York. African-Americans comprised 7.4 percent of the population compared to 15.9 percent for the State. Other minority groups comprise less than 5 percent of the total population of the ROI and 11 percent of the State population. Persons of Hispanic ethnicity accounted for 6.3 percent of the ROI residents and 12.3 percent of State residents. Finally, the ROI is relatively affluent with only 4.2 percent of the population living below the poverty level (defined in 1990 as income less than $13,359 for a family of four) compared to 13 percent of all residents of New York. There are no identified Tribal areas or concentrated low-income or minority populations in the census tracts immediately surrounding the HFBR.

Table 3.13–1. Selected Demographic Characteristics for the BNL Region of Influence

Characteristics/Area	**Suffolk County (number)**	**Nassau County (number)**	**ROI (number)**	**ROI (percent)**
Persons by Race/Ethnicity				
White	1,190,315	1,115,119	2,305,434	88.4
Black	82,910	111,057	193,967	7.4
American Indian	2,994	1,642	4,636	0.2
Asian/ Pacific Islander	23,100	39,299	62,399	2.4
Other	22,545	20,231	42,776	1.6
Hispanic	87,542	77,386	165,234	6.3
Total 1990 Population	1,321,864	1,287,348	2,609,212	--
1989 Low Income				
Persons below Poverty				
Number	61,389	47,192	108,581	
Percent	4.7	3.7	4.2	

Note: Persons of Hispanic ethnicity may be of any race.
Source: Census 1994.

Figure 3.13-1 Minority Populations Surrounding the Brookhaven National Laboratory.

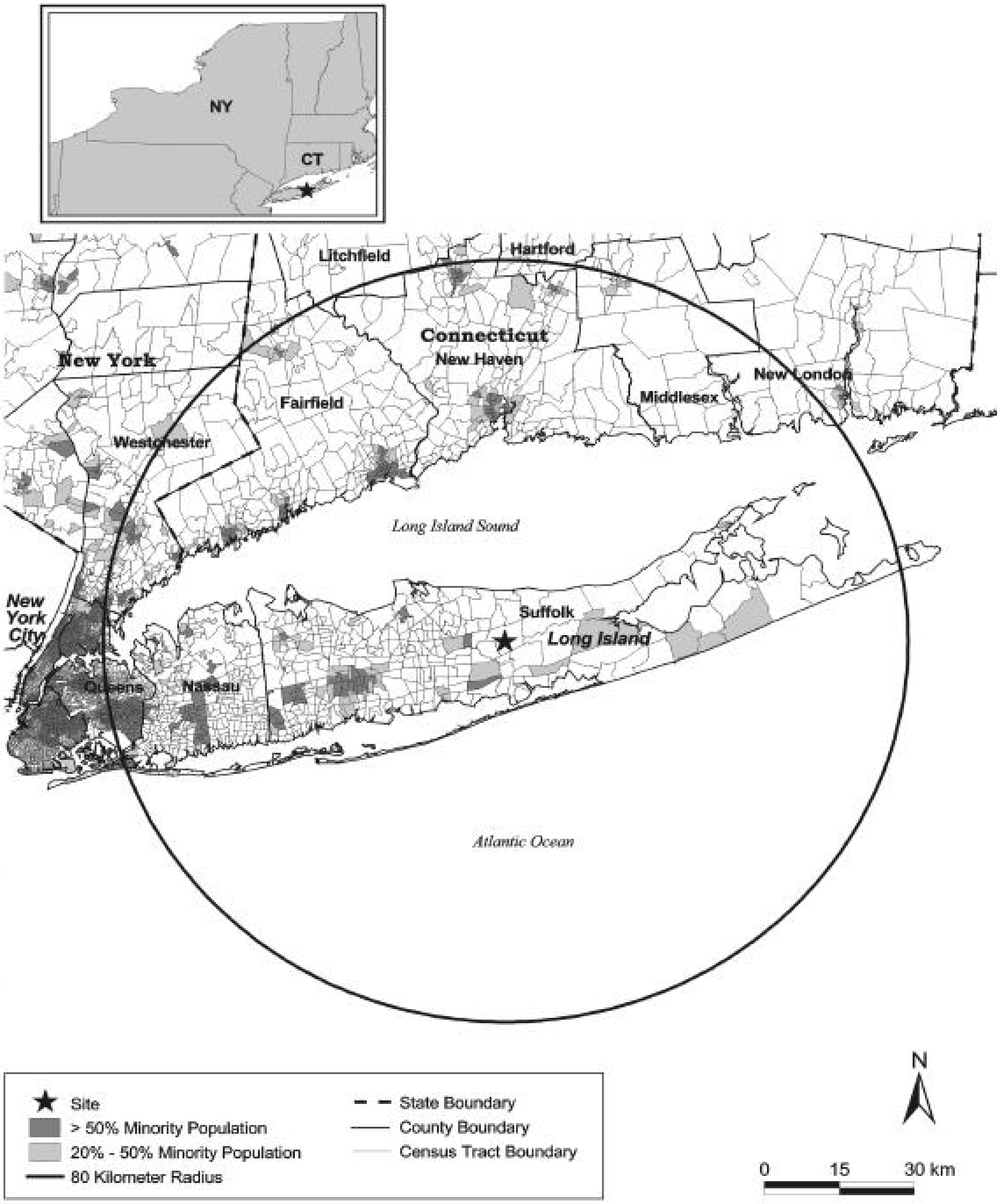
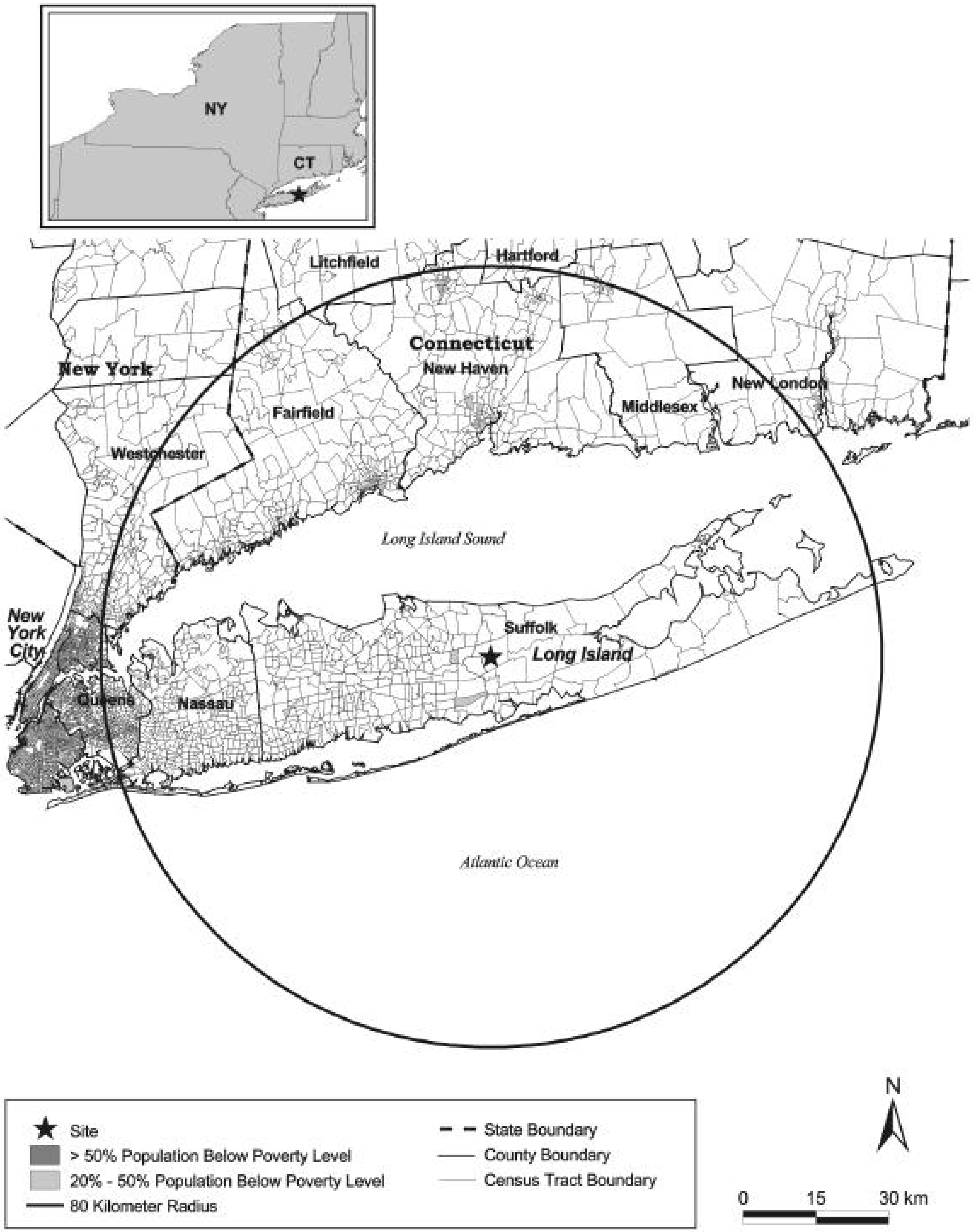


Figure 3.13-2 Low-Income Populations Surrounding the Brookhaven National Laboratory.



3.14 REFERENCES

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